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Eelgrass in Puget Sound

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CONTENTS

Cover: Eelgrass, an important part of the Puget Sound, Wash., ecosystem, is discussed in the article beginning on page 18.

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What Is A Tuna?

W. L. KLAWE

W. L. Klawe is a Senior Scientist with the Inter-American Tropical Tuna Commission, Scripps Institution of Oceanography, La Jolla, CA 92037.

The word "tuna" is applied to certain members of the family Scombridae, a group of marine fishes containing also bonitos, mackerels, seerfishes (or Spanish mackerels) and the butterfly kingfish. "Tuna" is a newcomer to the English language. It seems to have come into use in the second half of the last century but it is not clear why it replaced the older name "tunny." Most likely "tuna" as a name for fish originated in California with immigrant fishermen. There is evidence that the Spanish-speaking Californians, prior to 1848, used the word "tuna" only as the name of a fruit of an edible cactus. Lyman (1970), argues in favor of an Italian origin of the word as applied to fish. He postulates that in southern California the word tuna was applied to the bonito, *Sarda chiliensis,* by fishermen originating in the Ligurian Sea area, and that the name eventually was transferred to other fish which had been known as tunny. It should be pointed out, however, that Lyman overlooked two important facts: 1) That at the time we think the name tuna was adopted by the English-speaking Californians, there were indeed in California fishermen originating from the Dalmatian coast of Yugoslavia (formerly part of the Austro-Hungarian monarchy), and their native name for tunny was "tuna"; 2) The name tuna could also have been brought to southern California during the second half of the nineteenth century by people from the Iberian Peninsula, i.e., the Spaniards, Portuguese, and Basques, whose names for tuna included tunnina, tonina, tohinha, or atuna, among others. The English word tuna may have been derived from these. Thus for the time being, we must conclude that the process by which the word "tuna" gained entry into American usage is unknown[1].

To ichthyologists, the biologists who study fishes including their classification, tuna is any of 13 species of the tribe Thunnini within the family Scombridae. Species, genera, tribes, families, and all other taxonomic units used by scientists to classify all the animals and plants are in Latin, and this biological classification is organized so that it reflects the relationship of organisms, both extinct and present, to each other. In other words, this classification attempts to account for the evolutionary history of the organisms in question. The relationship among the present members of the family Scombridae is shown in Figure 1. The tribe Thunnini corresponds to what ichthyologists consider to be the tunas, and this tribe is comprised of the following species:

Bullet tuna	*Auxis rochei*
Frigate tuna	*Auxis thazard*
Kawakawa	*Euthynnus affinis*
Little tunny	*Euthynnus alletteratus*
Black skipjack	*Euthynnus lineatus*
Skipjack tuna	*Katsuwonus pelamis*
Albacore	*Thunnus alalunga*
Yellowfin tuna	*Thunnus albacares*
Blackfin tuna	*Thunnus atlanticus*
Southern bluefin tuna	*Thunnus maccoyii*
Bigeye tuna	*Thunnus obesus*
Northern bluefin tuna	*Thunnus thynnus*
Longtail tuna	*Thunnus tonggol*

These species, together with the rest of the scombrids, are listed in Table 1, where the scientific as well as the common names are given. The geographical distribution is also given for each of the species. The common names used in Table 1 are those names which are currently used by the fishermen, scientists, international fisheries bodies, trading companies, fish processors, and other people who concern themselves

[1]Klawe, W. L. 1976. *Tuna* as an English word for a scombrid fish. Inter-Am. Trop. Tuna Comm., La Jolla, CA 92037 (Unpubl. manuscr.).

Figure 1.—The subfamilies, tribes, genera, and number of species of the family Scombridae (based on Collette and Chao, 1975).

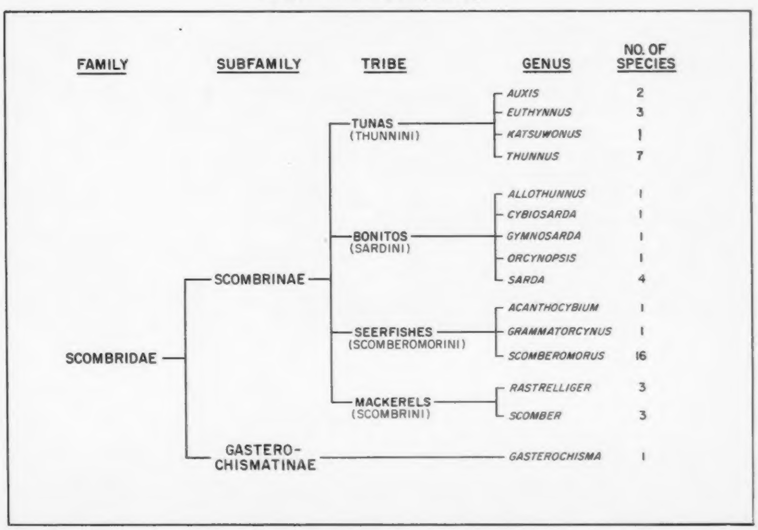


Table 1.—Alphabetical list of genera and species of scombrid fishes and the geographical distribution of each species.

Tunas, bonitos, seerfishes, butterfly kingfish, and mackerels
Family Scombridae

Acanthocybium Gill, 1862
Wahoo
Acanthocybium solandri (Cuvier *in* Cuvier and Valenciennes, 1831)
Tropical and subtropical waters of the Indian, Pacific, and Atlantic Oceans including the Mediterranean Sea.

Allothunnus Serventy, 1948
Slender tuna
Allothunnus fallai Serventy, 1948
Southern Ocean, south of lat. 20°S; one record from eastern Pacific.

Auxis Cuvier, 1829[1]
Bullet tuna
Auxis rochei (Risso, 1810)
Warm waters of the Indian, Pacific, and Atlantic Oceans, including the Mediterranean Sea.

Frigate tuna
Auxis thazard Lacépède, 1800)
Warm waters of the Indian, Pacific, and Atlantic Oceans.

Cybiosarda Whitley, 1935
Leaping bonito
Cybiosarda elegans (Whitley, 1935)
Northern ¾ of Australia.

Euthynnus Lütken *in* Jordan and Gilbert, 1883
Kawakawa
Euthynnus affinis (Cantor, 1849)
Warm waters of the Indian and Pacific Oceans; few records from the eastern Pacific Ocean.

Little tunny
Euthynnus alletteratus (Rafinesque, 1810)
Warm waters of the Atlantic Ocean including the Mediterranean Sea; sporadic occurrence in the Black Sea.

Black skipjack
Euthynnus lineatus Kishinouye, 1920
Warm waters of the eastern Pacific Ocean; stray specimens recorded from the central Pacific Ocean.

Gasterochisma Richardson, 1845
Butterfly kingfish
Gasterochisma malampus Richardson, 1845
Throughout the southern hemisphere, mostly between lat. 35°S and at least lat. 50°S; in the southeastern Indian Ocean as far north as lat. 26°S; distribution appears to parallel the zone of the West Wind Drift.

Grammatorcynus Gill, 1862
Double-lined mackerel
Grammatorcynus bicarinatus (Quoy and Gaimard, 1824)
Red Sea; absent from the Arabian Sea and Bay of Bengal; present off southeast Asia, Australia, Papua New Guinea, Philippines, Ryukyus, Marshalls, and Tonga.

Gymnosarda Gill, 1862
Dogtooth tuna
Gymnosarda unicolor (Rüppell, 1838)
Red Sea and East Africa eastward to Australia, Papua New Guinea, Marshalls, Society Islands, and Marquesas; sporadic in Japanese waters.

Katsuwonus Kishinouye, 1915
Skipjack tuna
Katsuwonus pelamis (Linnaeus, 1758)
Cosmopolitan in warm waters; absent from the Black Sea.

Orcynopsis Gill, 1862
Plain bonito
Orcynopsis unicolor (Geoffroy St. Hilaire, 1817)
West coast of Africa northward from Gulf of Guinea, and in the Mediterranean Sea.

Rastrelliger Jordan and Starks *in* Jordan and Dickenson, 1908
Short mackerel
Rastrelliger brachysoma (Bleeker, 1851)
Malaysia, Indonesia, Papua New Guinea, Solomons, and Fiji Islands.

Island mackerel
Rastrelliger faughni Matsui, 1967
Philippines, Taiwan, Papua New Guinea, and Indonesia.

Indian mackerel
Rastrelliger kanagurta (Cuvier, 1817)
East coast of Africa, Seychelles, Arabian Sea, eastward through Indonesia and off northern Australia to Melanesia and Micronesia, Samoa, coast of People's Republic of China, and Ryukyus; recently recorded from the Mediterranean Sea.

Sarda Cuvier, 1829
Australian bonito
Sarda australis (Macleay, 1880)
Distribution limited to southeastern coast of Australia from the Tropic of Capricorn south to Tasmania and at Norfolk Island.

Eastern Pacific bonito
Sarda chiliensis (Cuvier *in* Cuvier and Valenciennes, 1831)
Eastern Pacific Ocean from Vancouver Island to Baja California; absent from truly tropical waters of Middle America and then present again from Peru to northern Chile.

Indo-Pacific bonito
Sarda orientalis (Temminck and Schlegel, 1844)
Coastal regions of the Indian and Pacific Oceans; also present around many of the islands; east coast of Africa, Red Sea, Arabian Sea, Gulf of Bengal, western Australia, Indonesia, People's Republic of China, Formosa, Japan, occasionally in Hawaiian waters; in the eastern Pacific, Middle America to Ecuador, including the Galapagos Islands.

Atlantic bonito
Sarda sarda (Bloch, 1793)
Atlantic Ocean, Mediterranean and Black Seas.

Scomber Linnaeus, 1758
Spotted chub mackerel
Scomber australasicus Cuvier *in* Cuvier and Valenciennes, 1831
Western Pacific Ocean, off Australia, New Zealand, People's Republic of China, Japan, Hawaii, and Revillagigedos in the eastern Pacific.

Chub mackerel
Scomber japonicus Houttuyn, 1782
Temperate and warm waters of both hemispheres, present in the Mediterranean Sea.

Atlantic mackerel
Scomber scombrus Linnaeus, 1758
Temperate and near-temperate waters of the Atlantic Ocean, including the Mediterranean and the Black Seas.

Scomberomorus Lacépède, 1802[2]
King mackerel
Scomberomorus cavalla (Cuvier, 1829)
Tropical western Atlantic Ocean.

Narrow-barred king mackerel
Scomberomorus commerson (Lacépède, 1800)
Indian and western Pacific Oceans, Cape of Good Hope, east Africa, Red Sea eastward to Malaysia, Australia, Indonesia, Fiji, Philippines, People's Republic of China, Formosa, and Japan; recent immigrant to the Mediterranean Sea.

Monterey Spanish mackerel
Scomberomorus concolor (Lockington, 1879)
Gulf of California, formerly abundant in Monterey Bay, California.

Indo-Pacific king mackerel
Scomberomorus guttatus (Bloch and Schneider, 1801)
Indian and Pacific Oceans from Japan to India.

Korean seerfish
Scomberomorus koreanus (Kishinouye, 1915)
Indian and Pacific Oceans from Korea to India.

Streaked seerfish
Scomberomorus lineolatus (Cuvier *in* Cuvier and Valenciennes, 1831)
Coastal waters of India and Ceylon eastward to Southeast Asia and Indonesia.

Atlantic Spanish mackerel
Scomberomorus maculatus (Mitchill, 1815)
Tropical and subtropical waters of the western Atlantic Ocean from Massachusetts to Rio de Janeiro; absent from the West Indies.

Papuan seerfish
Scomberomorus multiradiatus Munro, 1964
Shallow waters of Gulf of Papua off the mouth of the Fly River.

Japanese Spanish mackerel
Scomberomorus niphonius (Cuvier *in* Cuvier and Valenciennes, 1831)
Korea, Japan, China, Papua New Guinea, and Australia.

Kanadi kingfish
Scomberomorus plurilineatus Fourmanoir, 1966
Along the east African coastline from Kenya to South Natal; along the west coast of Madagascar.

Queensland school mackerel
Scomberomorus queenslandicus Munro, 1943
East and west coasts of Australia.

Cero
Scomberomorus regalis (Bloch, 1793)
Tropical and subtropical waters of the western Atlantic Ocean, particularly in the West Indies.

Broad-barred king mackerel
Scomberomorus semifasciatus (Macleay, 1884)
Off Queensland and the Northern Territory of Australia, southern Papua New Guinea.

Sierra
Scomberomorus sierra Jordan and Starks *in* Jordan, 1895
Eastern Pacific Ocean, from California south to Peru and around the Galapagos Islands.

Chinese seerfish
Scomberomorus sinensis (Lacépède, 1800)
Western Pacific Ocean from Japan to South Viet-Nam; present also in Cambodia in the Mekong system (does not reproduce in fresh water).

Western African Spanish mackerel
Scomberomorus tritor (Cuvier *in* Cuvier and Valenciennes, 1831)
Eastern Atlantic, off west coast of Africa; rare in the Mediterranean Sea.

Thunnus South, 1845
Albacore
Thunnus alalunga (Bonnaterre, 1788)
Temperate and tropical waters of all oceans, including the Mediterranean Sea.

Yellowfin tuna
Thunnus albacares (Bonnaterre, 1788)
Tropical and subtropical waters of the Indian, Pacific, and Atlantic Oceans.

Blackfin tuna
Thunnus atlanticus (Lesson, 1830)
Western Atlantic Ocean, off Martha's Vineyard, Massachussetts, southward through the Caribbean Sea to Brazil.

Southern bluefin tuna
Thunnus maccoyii (Castelnau, 1872)
Subtropical and temperate waters of the southern region of the Indian, Pacific, and Atlantic Oceans.

Bigeye tuna
Thunnus obesus (Lowe, 1839)
Warm waters of the Indian, Pacific, and Atlantic oceans.

Northern bluefin tuna
Thunnus thynnus (Linnaeus, 1758)
Subtropical and temperate waters of the north Pacific Ocean, south and north Atlantic Oceans, and in the Mediterranean and Black Seas.

Longtail tuna
Thunnus tonggol (Bleeker, 1851)
Indian and west Pacific Oceans, from southern Japan where it is rare, south to Australia (north, east and west coasts); throughout most of the Indian Ocean, including the Red Sea but absent from most of the east African coast.

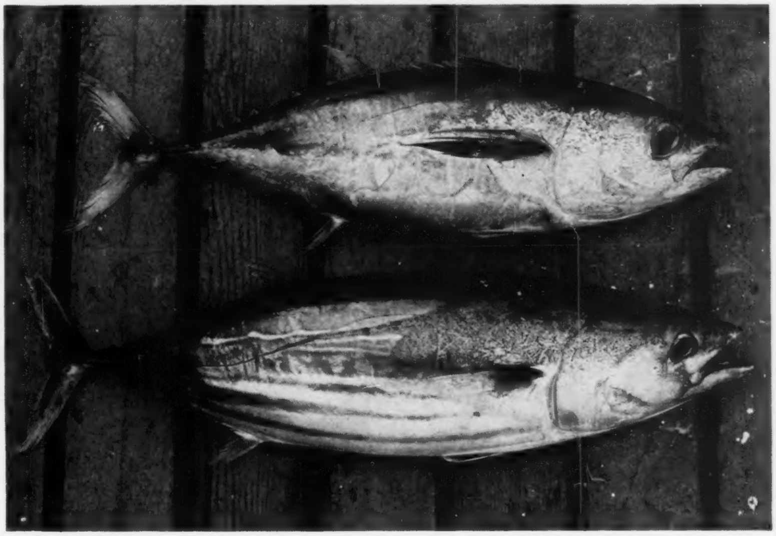
[1]The common name used by American tuna fishermen for both species of *Auxis* is "bullet." The names "bullet tuna" and "frigate tuna" employed in this list conform with the recommendation of the Ad Hoc Committee of Specialists to Review the Biology and Status of Stocks of Small Tunas (Anonymous, 1976). This recommendation was directed to countries as well as to international fisheries organizations. The use of "frigate tuna" and "bullet tuna" as common names may be of some controversy because for a long time the English language scientific literature has been employing the name "frigate mackerel" for *Auxis thazard* (i.e., Goode, 1884). It may be added that "bullet mackerel," on the other hand, is of recent coinage (Richards and Randall, 1967).

[2]At the time of writing, the taxonomy of the genus *Scomberomorus* is being critically reviewed and additional species are being described. Bruce B. Collette, Systematics Laboratory, National Marine Fisheries Service, NOAA, National Museum of Natural History, Washington, DC 20560, personal communication.

with tunas. If we examine the common names we discover that other scombrids, such as *Allothunnus fallai* and *Gymnosarda unicolor,* the slender tuna and dogtooth tuna, are also called "tunas." However, as seen in the outline of the family Scombridae (Fig. 1) they are actually bonitos. This is easily understood when we consider the fact that common names do not follow strict rules (Cohen, 1974), such as are used by scientists studying the relationship of the subfamilies and tribes within the family Scombridae. In Table 1, the scientific name of each genus and species, i.e., *Katsuwonus pelamis,* is followed by a name and a year. Sometimes the name is enclosed in parentheses, and sometimes not. In the case of *Katsuwonus pelamis,* it is followed by "(Linnaeus, 1758)." This indicates that this species was described by the Swedish naturalist Carl Linné in 1758 who, according to the custom of the period, Latinized his name to "Carolus Linnaeus." The parentheses denote that when Linné described the species he placed it in a different genus, the original name being *Scomber pelamis.* When the parentheses are omitted, it indicates that the author, in his description of the species, used the generic name still in use for a given species. Thus, if we look up *Allothunnus fallai* Serventy, 1948 in Table 1, we discover that the species was originally described in the genus *Allothunnus.*

Although each of the species in Table 1 has one listed common name, in reality some of the fish have many such names. *Katsuwonus pelamis,* or skipjack tuna, is known in some parts of the English-speaking world as "bonito" or "oceanic bonito," but in Hawaii it is often referred to as "aku," which is a Polynesian name. In Table 1, we also note that the name "mackerel" is applied to many species of the seerfishes. Further, the name mackerel is even used for members of families other than the Scombridae. Of course, all this results in a certain degree of confusion stemming from the use of common names.

Yellowfin tuna, top, photographed inside a tuna seine. Below is a small yellowfin tuna (above) and a skipjack tuna (beneath). Photographs by William L. High, Northwest and Alaska Fisheries Center, NMFS, NOAA, Seattle, Wash.



To illustrate further the vagaries of common names, we may consider the fact that in Australia the name "northern bluefin tuna" is applied not to *Thunnus thynnus,* but to *Thunnus tonggol.* Among the Australian tunas, there are two similar species—*Thunnus maccoyii,* which occurs off the southern coast and is known as the southern bluefin tuna, and *Thunnus tonggol,* which occurs off the northern coast of Australia and is called northern bluefin tuna. Thus it is not surprising that scientific names were devised to help scientists avoid the ambiguities arising from the use of common names. Each generic name is unique. No other species of fish (or of any other animal) may have the same combination of generic and species (trivial) names. Since scientific names are accepted around the world, they assure that the global scientific community can communicate about the particular organisms involved.

However, even scientific names change with time. Changes in the scien-

SCIENTIFIC NOMENCLATURE		VERNACULAR NOMENCLATURE	
CURRENT USAGE	FDA USAGE	CURRENT USAGE	FDA USAGE
Thunnus thynnus	Thunnus thynnus Thunnus orientalis	Northern Bluefin Tuna	Bluefin Tuna Oriental Tuna
Thunnus maccoyii	Thunnus maccoyii	Southern Bluefin Tuna	Southern Bluefin Tuna
Thunnus alalunga	Thunnus germo	Albacore	Albacore
Thunnus atlanticus	Thunnus atlanticus	Blackfin Tuna	Blackfin Tuna
Thunnus obesus	Parathunnus mebachi	Bigeye Tuna	Big-eyed Tuna
Thunnus albacares	Neothunnus macropterus	Yellowfin Tuna	Yellowfin Tuna
Thunnus tonggol	Neothunnus rarus	Longtail Tuna	Northern Bluefin Tuna
Katsuwonus pelamis	Katsuwonus pelamis	Skipjack Tuna	Skipjack
Euthynnus affinis	Euthynnus yaito	Kawakawa	Kawakawa
Euthynnus alletteratus	Euthynnus alletteratus	Little Tunny	Little Tunny
Euthynnus lineatus	Euthynnus lineatus	Black Skipjack	Little Tunny

Figure 2.—Tunas, as defined by the U.S. Food and Drug Administration.

tific nomenclature are the results of continuous research on the identity of various species and their relationships to each other. Much taxonomic research has been done on the family Scombridae, including tunas, over the past 25 years. As a result, many changes have been made in the names already in existence and many species of tunas, which were believed to be distinct from each other, have been proven to be the same species.

To illustrate this, consider the northern bluefin tuna, which inhabits both the Atlantic and Pacific Oceans (Table 1). A few years ago, scientists considered *Thunnus thynnus* to be divided into three distinct, geographically separated species: *Thunnus thynnus*, *Thunnus saliens*, and *Thunnus orientalis*. Northern bluefin tuna off California and Baja California were known as *Thunnus saliens* and those from the western Pacific Ocean as *Thunnus orientalis*. On the basis of experiments with plastic tags affixed to living fish, scientists demonstrated interchange of *Thunnus saliens* and *T. orientalis* between the eastern and western Pacific, concluding from this that only one species was involved. Further research based on anatomy indicated that the bluefin from the north Pacific and from the Atlantic belong to the same species. However, Gibbs and Collette (1967), who conducted these studies concluded that there were enough differences between the Pacific and Atlantic populations of the northern bluefin tuna to consider them different on a subspecific level. These fish therefore are sometimes referred to as *Thunnus thynnus thynnus* and *Thunnus thynnus orientalis*. Thus we may say that *Thunnus saliens* and *Thunnus orientalis* are synonyms of *Thunnus thynnus*. In reference to the variability of common names, and to the synonyms of scientific names the following saying carries a great deal of truth: "Common names change from place to place, whereas scientific names change from time to time."

The Food and Drug Administration (FDA), a branch of the U.S. Department of Health, Education, and Welfare, includes among its various activities the development of standards for foods, including canned tuna. In the Code of Federal Regulations, FDA defines and gives standards of identity for fish which may be processed into a canned product labeled "tuna." The FDA's list contains several scientific and common names which are no longer in use, and therefore these names have been updated in Figure 2. It should be noted that *Auxis rochei* and *Auxis thazard*, or the bullet and frigate tunas, are not included on the FDA list of tunas, and thus a canned product made from these species cannot bear the label "tuna."

The various bonitos of the genus *Sarda*, when canned, resemble canned tuna in taste and appearance. Such products, however, must be sold in the United States as "bonito." In some other countries, Canada for example, canned bonito is sold as tuna and is labeled as "tuna (bonito)." This statement should not be taken as criticism of the FDA or of the equivalent organization in Canada, but only as a statement of fact.

Nearly all tunas in the United States are consumed in the canned form although small amounts are sold as fresh fish in some parts of the country. In Hawaii the aku, or skipjack tuna, is used in preparation of traditional Polynesian dishes. Because of the large population of Americans of Japanese ancestry in Hawaii there is also a considerable demand for fresh tuna to prepare a traditional Japanese hors d'oeuvre known as sashimi, sliced raw fish, which is dipped in a spicy sauce before eating. Another product used in Japanese cooking is the so-called katsuobushi, usually referred to as "dried bonito" and imported from Japan to the United States under the latter name. However, the term "dried bonito" is misleading, as the product is not bonito, but skipjack tuna. The fish is a highly processed product in which the fish first is boiled, the loins are separated and all bones are removed. The loins are then smoke-dried over a period of many days, after which mold is gradually permitted to grow on the loins. The finished product is produced by converting the fish loins into shaven flakes which are used mainly for making a soup stock. Katsuobushi is mentioned here to point out that one branch of the U.S. Government may consider *Katsuwonus pelamis* to be a tuna (FDA), whereas another may consider it to be a bonito (Bureau of Customs).

Do the various definitions of tuna in the English language correspond to a similar range of meanings for the same word in other languages? In some instances there is a close correspondence

Table 2.—Alphabetical list of genera and species of billfishes and the geographical distribution of each species.

Sailfish, marlins, and spearfishes
Family Istiophoridae

Istiophorus Lacépède, 1802
Sailfish
Istiophorus platypterus (Shaw and Nodder, 1791)
Widely distributed throughout tropical and subtropical waters of the world oceans; usually more abundant near land masses and some of the islands.

Tetrapturus Rafinesque, 1810
White marlin
Tetrapturus albidus Poey, 1861
Tropical and temperate waters, found only in the Atlantic and the Mediterranean.

Shortbill spearfish
Tetrapturus angustirostris Tanaka, 1914
An Indian and Pacific Ocean species found in warm waters; open-sea fish seldom encountered in coastal waters.

Striped marlin
Tetrapturus audax (Philippi, 1887)
An Indian and Pacific Ocean species found in warm waters; relatively rare in equatorial region of the central and western Pacific.

Mediterranean spearfish
Tetrapturus belone Rafinesque, 1810
Mediterranean Sea.

Roundscale spearfish
Tetrapturus georgei Lowe, 1840
In the Atlantic off Portugal and Spain, in the Mediterranean off Sicily.

Longbill spearfish
Tetrapturus pfluegeri Robins and de Sylva, 1963
Open waters of the tropical and subtropical Atlantic.

Makaira Lacépède, 1802
Black marlin
Makaira indica (Cuvier *in* Cuvier and Valenciennes, 1831)
Mainly a species of the Indian and Pacific Oceans, sporadic occurrence in the Atlantic Ocean; tropical fish much more abundant in coastal waters than in waters of the open sea, where it is present only in small numbers.

Blue marlin
Makaira nigricans Lacépède, 1802
Widely distributed throughout the Indian, Pacific, and Atlantic Oceans; especially abundant in the tropical regions.

Swordfish
Family Xiphiidae

Xiphias Linnaeus, 1758
Swordfish
Xiphias gladius Linnaeus, 1758
Widely distributed throughout the temperate and the tropical waters of the world oceans and the adjacent seas; found in coastal as well as in oceanic areas.

of meaning and in others there is not. The lack of agreement can be illustrated by the Japanese language. The Japanese consider the skipjack tuna to be a bonito, rather than a tuna. To the Japanese, the bullet and frigate tuna, the black skipjack, the kawakawa, and the little tunny are various kinds of bonitos, creating a kind of linguistic gap between the Japanese and English languages. To translate the word "tuna" (meaning members of the tribe Thunnini) into Japanese it is necessary to use a three-word expression katsuo to maguro. According to a Japanese-English dictionary this may be translated as "skipjack tuna and tunas" or "bonitos and tunas." Furthermore, we find that among the Japanese general population the word maguro, the closest equivalent to "tuna," may include not only all species of the genus *Thunnus,* but on occasion even billfishes. Another example of change in meaning from one language to another can be illustrated by the name "albacore," a word which has cognates in other languages. However, in some languages there is a shift of meaning. Thus, the French name albacore refers to the yellowfin tuna, *Thunnus albacares,* and not to *T. alalunga*. In Spain the albacore is usually called atún blanco although the name albacora is also used for this fish. In some other Spanish-speaking countries the name albacora may mean different fish. For example, in Cuba the blackfin tuna, *T. atlanticus,* is called albacora, whereas in Chile it is the swordfish, *Xiphias gladius*.

Other classifications used in connection with tunas are the terms "principal" and "secondary market species." The principal species, all seven species of the genus *Thunnus* and the skipjack tuna, *Katsuwonus pelamis,* are the ones which are most sought for canning purposes. The secondary market species encompass the genera *Auxis* and *Euthynnus* of the tunas, the butterfly kingfish, the bonitos, and seerfishes. Another term often used in conjunction with tunas is "tuna-like fishes." Usually the term "tuna and tuna-like fishes" applies to the billfishes and all scombrids with the exception of the true mackerels, *Rastrelliger* and *Scomber*. The mackerels are excluded because their mode of life, the nature of mackerel fisheries, and the marketing of mackerel catches are quite different from the other tuna-like fishes.

The billfishes derive their name from a sword-like or a spear-like projection of the upper jaw. Many of them are caught in conjunction with the fishery for tunas. The billfishes are comprised of two families, Istiophoridae and Xiphiidae. The family Istiophoridae encompasses 3 genera and 10 species. The family Xiphiidae contains only one member, the swordfish, *Xiphias gladius*. All of the species of billfishes are listed in Table 2, with the geographical distribution for each.

What then is a tuna? In our everyday speech we are not too careful with our choice of words and often, when naming things, we use words or terms which lack precision. Even these poorly defined names serve our purpose, however, as long as we can communicate by using them. However, some aspects of human affairs require that words and terms be defined so exactly that there is no room for the possibility of misunderstanding. The word tuna, in addition to being an everyday word which may be used in relation to such a mundane thing as a sandwich, often has precise meanings defined by scientists as well as lawmakers.

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A Statistical and Budgetary Economic Analysis of Florida-Based Gulf of Mexico Red Snapper-Grouper Vessels by Size and Location, 1974-75

JAMES C. CATO and FRED J. PROCHASKA

INTRODUCTION

Economic and biological data on the Gulf of Mexico red snapper-grouper fishery have been limited until the last 2 years. This lack of data became apparent when the industry raised questions about declining catches per unit of fishing effort and lower economic returns. In response, a joint effort by fishery management personnel, regulatory agencies, and educational institutions was made during a colloquium to bring together available information on these fisheries (Bullis and Jones, 1976).

Economic data on prices, marketing, and production in the Gulf of Mexico red snapper-grouper industry are presented by Cato and Prochaska (1976). Further analysis on the costs and returns for Florida-based northern Gulf of Mexico commercial and recreational red snapper-grouper vessels is contained in two bulletins by Prochaska and Cato (1975a, b).

This paper combines the analysis of production data for the northern gulf commercial vessels with additional production data collected from the Florida west coast or southeastern gulf red snapper-grouper production area to provide a comparative report on the costs and returns for vessels operating in these two areas. Several uses exist for this type of analysis. These data provide a comparative basis from which individual vessel owners and captains can determine any needed changes in their business management or fishing practices. Prospective firms considering entering the fishery will have an estimate of the necessary production inputs, catch levels, and revenues necessary to be a viable production unit. Financial institutions will be better able to evaluate loan applications for vessels in the red snapper-grouper fishery by knowing their profit potential. Finally, an indication of the sales and purchases made by these fishing firms suggests their contribution to the economy.

This paper is based on personal interviews with boat owners and captains representing 20 commercial vessels. Although the boats and vessels were not selected using a statistically drawn sample, the data should provide an accurate representation of the average vessel. Careful evaluation of landings records and discussions with industry leaders led to the two main areas in which data on vessels were collected. Vessels within each area were suggested by commercial fishermen, fishhouse owners, and Sea Grant Advisory agents as those being most representative of commercial fishing areas in each area and size strata. Since these vessels fish offshore for long periods of time, the cost of collecting data from randomly drawn vessels when in port

James C. Cato is a Marine Economics Specialist with the Florida Sea Grant Marine Advisory Program and an Assistant Professor in the Food and Resource Economics Department, University of Florida, Gainesville, FL 32611. Fred J. Prochaska is an Associate Professor in the Food and Resource Economics Department, University of Florida, Gainesville, FL 32611.

Vessels such as these are used for snapper and grouper in the southeastern Gulf of Mexico.

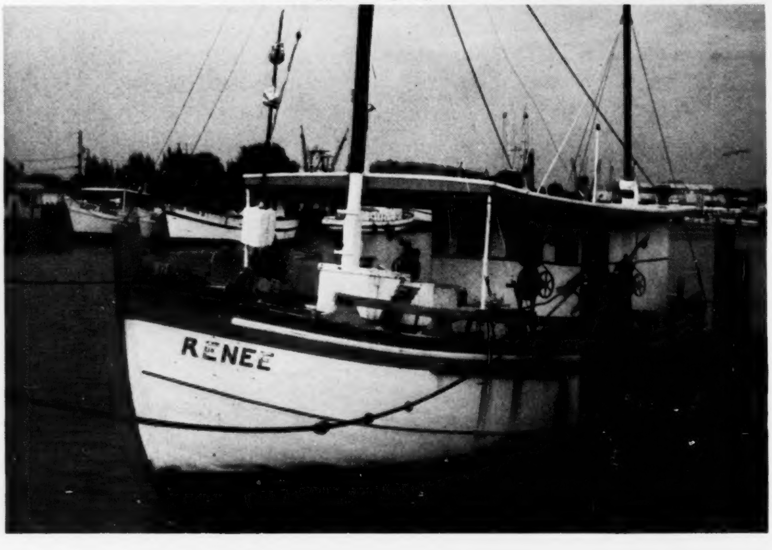


Table 1.—Production characteristics of Gulf of Mexico commercial red snapper-grouper fishing vessels by vessel size and production areas, annual averages for 1974 and 1975[1].

Vessel size and location	Crewmen including captain		Trips per year		Fishing effort: Days fished per year		Pounds caught per day[2]			
	Average	Range	Average	Range	Average	Range	Red snapper	Grouper	Other	Total
38 feet to 47 feet (small) Panama City to Pensacola[3]	2.3	2-3	19.0	11-24	199	168-220	164	142	20	326
Tarpon Springs to Madeira Beach[4]	2.1	1-3	20.5	14-24	203	126-240	65	213	31	309
56 feet to 69 feet (large) Panama City to Pensacola[5]	4.7	4-6	11.3	9-12	193	180-220	482	23	168	673
Tarpon Springs to Madeira Beach[6]	3.0	3	16.3	11-22	185	150-220	84	279	32	395

[1]Data from Panama City to Pensacola are from 1974. Data from Tarpon Springs to Madeira Beach are for 1975.
[2]Average catch per year from Table 4 divided by average days fished per year.
[3]An average of four vessels of wood construction ranging from 42 to 47 feet.
[4]An average of three wood, two fiberglass, and one steel vessel ranging from 38 to 45 feet.
[5]An average of four wood and two steel vessels ranging from 57 to 69 feet.
[6]An average of three wood and one fiberglass vessel ranging from 56 to 58 feet.

would be large. Also, the vessels used had accurate cost and return data. Some randomly selected vessels most likely would not have had records as accurate as those selected. The firm's home ports are in a seven-county area ranging from Panama City to Pensacola in northwest Florida, and Madeira Beach to Tarpon Springs[1], both located in Pinellas County, Fla. (Fig. 1). Florida landings of red snapper in 1974 were 5,168,918 pounds (63 percent of the U.S. total) and landings of grouper and scamps were 6,700,227 pounds (89 percent of the Florida total). Fishing operations for the vessels range as far west as Texas in the western Gulf of Mexico, the Campeche Shelf in the southern Gulf of Mexico, and the West Florida Shelf. The budget analysis reported for each area represents an average vessel in each of two vessel size groups. The small vessels are from 38 to 47 feet in length, large vessels are from 56 to 69 feet in length (Table 1). Size class was determined based on the ability of vessels to fish different areas. Large northern vessels normally range farther and have more extended trips than those in the smaller class. Large southeastern vessels more often fish the Campeche Shelf than do the small vessels which tend to concentrate fishing effort on the West Florida Shelf.

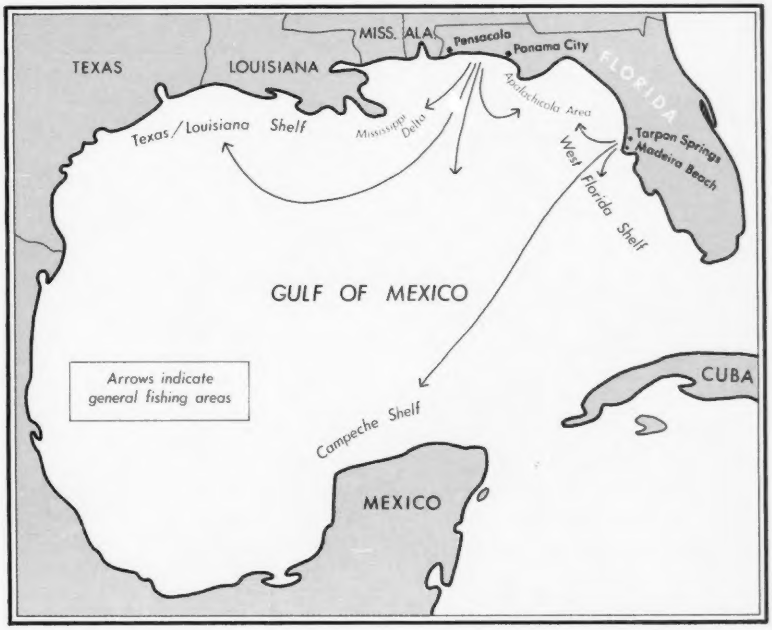


Figure 1.—Port areas and general fishing areas for vessels included in red snapper-grouper cost and returns analysis.

Small vessels carried an average of 2.1 (southeastern gulf) and 2.3 (northern gulf) crewmen (including captain) per trip while the two large classes carried 3.0 and 4.7 crewmen. Average number of trips per year (and days fished per year) was similar for both small vessel classes at 19.0 (199 days) and 20.5 (203 days). Large northern vessels averaged only 11.3 trips per year (193 days) while the large southeastern vessels averaged 16.3 trips (185 days). Pounds of fish caught per day of fishing effort averaged 673 for the large northern vessels and 395 for the large southeastern vessels. Pounds caught per day for the small northern and southeastern vessels were 326 and 309, respectively.

Two methods of analysis were used

[1]Data for Panama City to Pensacola were for 1974. Vessels from this area will be referred to in the text as the northern gulf vessels. Data for Tarpon Springs to Madeira Beach were for 1975. Vessels from this area will be referred to in the text as southeastern gulf vessels.

Catches of red snapper like this occur on a "down" of the gear when fish are plentiful and the fisherman is experienced.

to analyze the cost and returns data. First, an ordinary least squares regression equation using dummy variables was used to determine if statistically significant differences exist in costs and revenues between port locations and size of the fishing firm[2]. Second, specific differences in costs and revenues by firm size and port location are analyzed using detailed cost and return budgets for the four classes of vessels.

STATISTICAL ANALYSIS OF COSTS AND REVENUES BY AREA AND FIRM SIZE

Ordinary least squares regression[3] was used to analyze the variables in the econometric model in order to determine the effect of their variation on revenues and costs in the fishery. The theoretical economic and statistical considerations and interpretations of the model are presented in the first section. Empirical estimates and their implications are then discussed.

Econometric Model

Variables considered in this analysis which affect landings and associated costs and returns are 1) differences in the resource productivity of the fishery related to abundance and species mix of the biomass, and 2) size of the fishing operation and intensity of effort[4]. A proxy variable indicating area fished was used as a measure of resource productivity in the econometric model. This measurement assumes the total fish resource and individual species are relatively more or less abundant among different fishing areas. Thus, landings and revenues per unit of fishing effort are expected to be greater in the more productive fishing area with lower costs per unit of catch since costs per unit of effort should be the same among areas[5]. Consequently, net revenues are theoretically expected to be higher in the more productive fishery.

Size of the fishing vessel has both economic advantages and disadvantages. Increased size allows such advantages as longer trips, more crewmen and thus more effort per fishing day, and more carrying capacity. At the same time, larger vessels normally incur greater costs due to more extensive fuel demand, the need for more maintenance, and higher crew support costs. The economic question addressed in this study is whether additional revenues associated with size exceed additional costs.

The effect of either of the variables independent of the other could be determined by comparing vessels of the same size between areas or comparing vessels of two or more size classes within one area. Multiple regression techniques allow these independent comparisons with the advantage of using all observations simultaneously rather than using only vessel size and fishing area subsamples. Multiple regression also has the advantage of increased degrees of freedom and the parameter estimates are efficient[6]. In this paper the regression models estimated were of the following form:

$$Y_j = \alpha + \beta_1 A_j + \beta_2 S_j + \beta_3 (AS)_j \quad (1)$$

where: Y_j = the dependent revenue or cost variable for the jth vessel

A_j = variable for the area fished by the jth vessel

S_j = variable for vessel size for the jth vessel

$(AS)_j$ = interaction term denoting a different response for vessel size depending on area fished

α, β_1, β_2, and β_3 = parameters to be estimated.

The theoretical statement of the effect on Y of fishing alternative fishing areas adjusted for or independent of differences in vessel size is given by Equation (2):

$$\frac{\partial Y}{\partial A} = \beta_1 + \beta_3 S. \quad (2)$$

The parameter β_1 represents the "basic" effect of area on Y and β_3 the additional effect resulting from vessel size. The partial effect on Y of vessel size adjusted for area is given by

$$\frac{\partial Y}{\partial S} = \beta_2 + \beta_3 A. \quad (3)$$

[2]This comparative analysis assumes that the captains and crewmen of each vessel class have equal fish finding and catching skills. This assumption is necessary due to the inability to measure and document actual differences in fishing "skill" as it might affect operating cost and returns.

[3]This analysis will yield the same results as an analysis of variance with unequal replications.

[4]These are in addition to other factors such as units of effort which will be addressed later in this paper.

[5]Note that cost per unit of fishing effort and cost per unit of actual catch are two different measures.

[6]Unbiased and possess minimum variance.

Again, β_2 is the "basic" effect and β_3 the additional effect due to area. In this formulation the area effect on Y is dependent on the size of the fishing vessel [Equation (2)] while the effect of size on Y is dependent on the area fished [Equation (3)].

Data Specification

For purposes of this study, specific variables for the five models [estimated with Equation (1)] are defined by Equation (4):

$$Y_{ij} = a + B_1 A_j = B_2 S_j + B_3 (AS)_j \quad (4)$$
$$i = 1, 2, \ldots, 5$$
$$j = 1, 2, \ldots, 20$$

where: Y_{ij} = total revenue (i=1), total cost (i=2), net revenue (i=3), variable cost (i=4), and fixed costs (i=5) for the jth vessel

A_j = dummy variable for fishing area of the jth vessel where A = 1 if northern gulf and A = 0 if southeastern gulf

S_j = dummy variable for size of the jth vessel where S = 1 if large vessel and S = 0 if small vessel

$(AS)_j$ = interaction term denoting a different response for larger vessels in the northern gulf compared with the southeastern gulf

a, B_1, B_2, and B_3 = parameters to be estimated.

The expected value of Y_i for small vessels (s) fishing in the southeastern gulf (e) is

$$E(Y_i)_{se} = a. \quad (5)$$

The constant term a in Equation (5) represents the mean level of Y_i for the southeastern gulf small vessel operations. This expected value occurs because all other terms drop from the model when A and S take on the value of zero.

Expected values for Y_i for the other size and fishing area classifications are given by Equations (6), (7), and (8). The term B_1 in Equation (6) represents the additive effect of a small vessel fishing in the northern gulf (n) compared with the same vessel fishing in the

$$E(Y_i)_{sn} = a + B_1 \quad (6)$$

$$E(Y_i)_{Le} = a + B_2 \quad (7)$$

$$E(Y_i)_{Ln} = a + B_1 + B_2 + B_3 \quad (8)$$

southeastern gulf [compare Equations (5) and (6)]. Likewise, the term B in Equation (7) represents the additive effect of a larger vessel (L) compared with a smaller vessel, both fishing in the southeastern gulf [compare Equations (5) and (7)]. Equation (8) represents the expected value for large vessels fishing in the northern gulf. In this case the term B_3 represents the interaction effect of size and area.

Table 2.—Regression analysis for revenue and costs by area and vessel size for the Gulf of Mexico red snapper-grouper industry.

Dependent variable (Y_i)	Constant	Area (A)	Size (S)	Interaction (AS)	R^2	F statistic
		Independent variables[1]				
Total revenue	30,380	10,972	5,162	50,510	0.80	21.68
	(6,490)	(10,270)	(10,270)	(14,520)		
Net revenue	10,280	5,241	−2,439	31,353	0.77	17.94
	(3,850)	(6,095)	(6,095)	(8,619)		
Total cost	20,100	5,730	7,601	19,157	0.65	10.08
	(4,460)	(7,055)	(7,055)	(9,978)		
Total variable cost	17,210	4,619	4,955	21,908	0.72	13.47
	(3,830)	(6,049)	(6,049)	(8,555)		
Total fixed cost	2,890	1,111	2,646	−2,750	0.13	0.80
	(1,080)	(1,714)	(1,714)	(2,424)		

[1]Numbers in parentheses are standard errors. All coefficients and constant term estimates are in dollars. Independent variables are: A = fishing area: 1 = northern gulf, 0 = southeastern gulf; S = vessel size: 1 = large, 0 = small; AS = interaction term.
For some variables the standard errors are larger than the estimated coefficient. However, this was not the case with the interaction term. Inclusion of the interaction term allows the analysis of the question of whether large boats are better in all areas rather than in just one specific area. This term also allows analysis of the significance of a combination of coefficients (see Equation 8 and Table 3). Models were estimated without the interaction term. The independent variables in these models did have lower standard errors in relation to the estimated coefficients. The economic and statistical questions addressed in the paper were more logically addressed by using the models which were specified to include the interaction term.

Table 3.—Estimated effects of fishing area and vessel size on revenues and costs for the Gulf of Mexico red snapper-grouper industry[1].

Dependent variable	Estimated increases due to fishing larger vessels: Northern gulf ($B_2 + B_3$)	Estimated increases due to fishing larger vessels: Southeastern gulf (B_2)	Estimated increases due to fishing the northern gulf: Large vessels ($B_1 + B_3$)	Estimated increases due to fishing the northern gulf: Small vessels (B_1)
	Dollars			
Total revenue	55,672***	5,162	61,842***	10,972*
Net revenue	28,914***	−2,439	36,594***	5,241
Total cost	26,758***	7,601*	24,887***	5,730
Total variable costs	26,863***	4,955	26,527***	4,619
Total fixed costs	−104	2,646**	−1,639	1,111

[1]Confidence levels for 99, 80, and 70 percent indicated by ***, **, and *, respectively.

Empirical Analysis

Estimated regression coefficients and the explanatory power for each of the five equations estimated are presented in Table 2. With the exception of the equation for total fixed cost, all estimated equations were highly significant (F statistic). Explanatory power for the four significant equations ranged from 65 to 80 percent of the total variation. Inferences drawn from the regression models are presented in Table 3.

Large vessels gross more revenue than smaller vessels in both areas of the Gulf of Mexico analyzed. However, the additional returns accruing to vessel size is much greater in the northern gulf than in the southeastern gulf. The estimated increase in total revenue due to larger size is $55,672 and is highly significant statistically in the northern gulf compared with an estimated $5,162 increase in the southeastern gulf which is not significantly different from zero statistically.

Total costs are also positively related to vessel size. Again, the effect is greater for larger vessels in the northern gulf. However, the increase in cost is less than proportional to increases in revenue for larger vessels in the northern gulf thus resulting in a significant

positive net revenue effect. The additional net returns from increased vessel size was $28,914 annually in the northern gulf while increased size of vessel in the southeastern gulf does not produce an effect significantly different from zero compared with smaller vessels in the same area (Table 3). Added variable costs of increased size in the northern gulf is the primary reason for the additional total cost. The negative effect on total fixed costs in the northern gulf area is not significantly different from zero statistically.

Fishing in the northern gulf increases revenues and costs for both vessel size classes compared with fishing in the southeastern gulf. However, only larger vessels produce significantly more net revenue in the northern gulf with an estimated additional net revenue of $36,594 for large vessels.

Table 4.—Expected or predicted values of cost and revenues by vessel size and fishing area.

Dependent variable	Predicted or expected values: Northern gulf large vessels [Equation (8)]	Southeastern gulf small vessels [Equation (5)][1]
	Dollars	
Total revenue	97,024	30,380
Net revenue	44,435	10,280
Total cost	52,588	20,100
Total variable costs	48,692	17,210
Total fixed costs	3,897	2,890

[1]These estimates are also applicable to large vessels in the southeastern gulf and small vessels in the northern gulf since no statistical significance exists between the expected values for these three groups of vessels.

A summary of the expected effects of area and size in terms of predicted or expected values for the average vessels is presented in Table 4. Predicted values for small vessels in the southeastern gulf using Equation (5) are equal to the constant term (mean values for these vessels). These expected values for small vessels in the southeastern gulf (Table 4) also represent the predicted values for large vessels in the southeastern gulf and small vessels in the northern gulf because the added effects expressed in Equations (6) and (7) are not statistically significantly different from zero (Table 3). Expected total revenue is greatest for large vessels in the northern gulf. Net revenues are also greater for these vessels in the northern gulf. Thus in summary, larger profits occur for larger vessels in the northern gulf but not for larger vessels in the southeastern gulf. No significant differences are found between small vessels fishing in the northern gulf compared with small vessels fishing the southeastern gulf.

COMPARATIVE BUDGET ANALYSIS OF COST AND RETURNS BY AREA AND FIRM SIZE

Landings and Revenues

Red snapper was the predominate species landed by northern gulf vessels (Table 5). Grouper production almost equaled red snapper production for the small northern gulf vessels but makes up an insignificant portion of the larger vessels' catch. Large vessels travel longer distances from their home ports to fishing grounds where red snapper are most abundant. The large volume of "other" species landed by the large vessels represents sizeable landings of croakers.

Grouper production represents the predominate catch for both the small and large southeastern gulf vessels in contrast to the northern vessels. Red snapper represents about one-fifth of the total catch while the catch of "other" fish was small. Total annual production of all fish was almost equal

Table 5.—Annual cost and returns for Gulf of Mexico commercial red snapper-grouper vessels by length class and production area, 1974 and 1975[1].

Item	38 feet to 47 feet (small): Northern gulf			38 feet to 47 feet (small): Southeastern gulf			56 feet to 69 feet (large): Northern gulf			56 feet to 69 feet (large): Southeastern gulf		
	Pounds	Dollars	Percent	Pounds	Dollars	Percent	Pounds	Dollars	Percent	Pounds	Dollars	Percent
Returns												
Red snapper	32,654	26,647	64.4	13,195	11,243	37.0	92,995	83,696	86.3	15,599	13,057	36.7
Grouper	28,325	12,899	31.2	43,334	17,281	56.9	4,409	1,985	2.0	51,518	20,203	56.9
Other	3,991	1,811	4.4	6,196	1,860	6.1	32,424	11,349	11.7	5,888	2,288	6.4
Total	64,970	41,357	100.0	62,725	30,384	100.0	129,828	97,030	100.0	73,005	35,548	100.0
Variable costs												
Fuel and oil		2,207	8.5		1,759	8.7		4,053	7.7		2,248	8.1
Groceries		2,721	10.5		2,166	10.7		5,211	9.9		2,364	8.5
Bait		1,978	7.6		1,804	9.0		5,955	11.3		1,907	6.9
Ice		1,171	4.5		836	4.2		2,317	4.4		1,072	3.9
Repairs and maintenance		4,565	17.5		6,349	31.6		10,278	19.6		6,511	23.5
Crews shares[2]		9,443	36.3		4,299	21.4		20,865	39.7		8,068	29.1
Total		22,085	84.9		17,213	85.6		48,679	92.6		22,170	80.0
Fixed costs												
Depreciation		2,770	10.6		1,875	9.3		3,842	7.3		2,500	9.0
License		52	0.2		52	0.3		55	0.1		52	0.2
Interest		793	3.1		200	1.0		0	0.0		1,620	5.8
Insurance		326	1.3		533	2.7		0	0.0		1,200	4.3
Docking fee		0	0.0		230	1.1		0	0.0		165	0.7
Total		3,941	15.2		2,890	14.4		3,897	7.4		5,537	20.0
Total cost		26,026	100.0		20,103	100.0		52,576	100.0		27,707	100.0
Total net return to captain and owner[3]		15,331			10,281			44,454			7,841	

[1]Data from the northern gulf (Panama City to Pensacola, Fla.) are from 1974. Data from the southeastern gulf (Tarpon Springs to Madeira Beach, Fla.) are for 1975. Some percentage totals may not add due to rounding of individual items.
[2]Crew shares are reported net of crew share of expenses.
[3]Total net returns to captain and owner represent captains' salaries, and return to owners' labor, management, and investment.

for the northern and southeastern gulf small vessels at 64,970 and 62,725 pounds, respectively. However, total production for the large northern vessels was 78 percent greater than the large southeastern vessels at 129,828 and 73,005 pounds, respectively.

A comparison of revenues earned per vessel shows the significance of red snapper in the total value of landings (Table 5 and Fig. 2). Red snapper represented 64 percent ($26,647) and 37 percent ($11,243) of total value of landings for the northern and southeastern vessels, respectively. For the larger vessels, northern vessels averaged 86 percent ($83,696) of the value in red snapper while the southeastern larger vessels maintained the same 37 percent ($13,057) as the small vessels in the southeastern gulf. In addition to the greater tonnage of red snapper landed by the northern gulf vessels, the higher price of red snapper (about double that of grouper) is also responsible for their significant share of total value of landings.

Grouper taken in the Gulf of Mexico are unloaded from the ice box for movement into the processing plant.

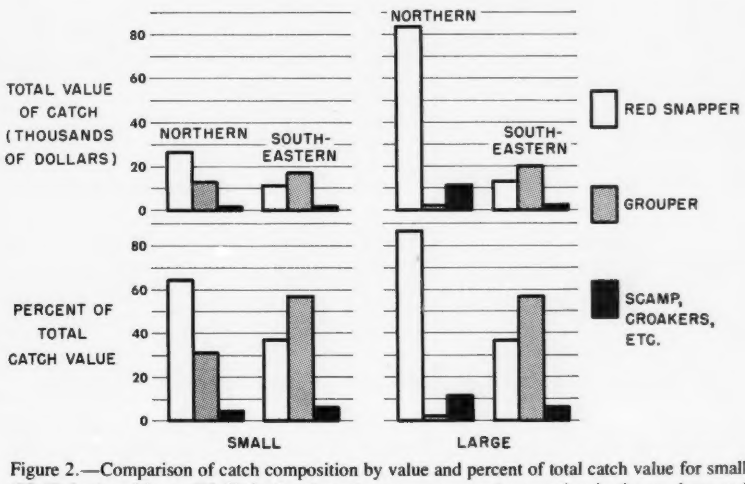


Figure 2.—Comparison of catch composition by value and percent of total catch value for small (38-47 feet) and large (56-69 feet) red snapper-grouper vessels operating in the northern and southeastern areas of the Gulf of Mexico, 1974 and 1975.

All species are valued in this paper at dockside prices paid to the captain or owner by the initial buyer (fish house). Several vessels were owned by companies rather than individual owners and valued their catch at slightly more than one-half of the common dockside value due to internal record keeping procedures and slightly different crew share arrangements. Dockside prices used in these cases were adjusted to be consistent with prices paid to the independent vessels. Dockside value represents the value the company could receive for their catch if it was sold to other fish houses at the same market level.

Food commodities often experience price fluctuation at the producer levels due to weather, seasonality, and other factors affecting their demand and supply. These kinds of fluctuations have not occurred in the dockside price paid for red snapper in Florida. Monthly and annual average prices have increased steadily during past years. For the years 1972 through 1975, monthly average prices varied less than 4 percent from the annual average. Annual average prices increased from 70.1 cents per pound in 1972 to 85.3 cents per pound in 1975. This stable and increasing price pattern has not caused large annual variations in costs and returns as is often seen in the production of some fish and food commodities.

Cost of Production

Total costs of production can be divided into two components—variable and fixed. Variable costs represent those that are incurred while engaged in the actual process of producing or catching a fish and vary with the amount of fishing effort. Variable costs will rise as the amount of fishing effort increases. That is, the more fishing days spent away from the dock each year, the higher will be the variable costs. Fixed costs represent those costs that are incurred regardless of whether or not the vessel is away from dock.

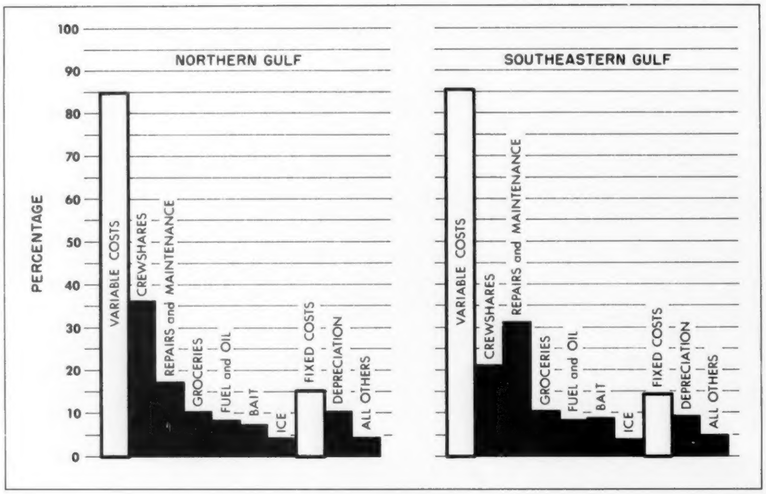


Figure 3.—Comparison of variable and fixed costs by type for small (38-47 feet) red snapper-grouper vessels operating in the northern and southeastern Gulf of Mexico, 1974 and 1975.

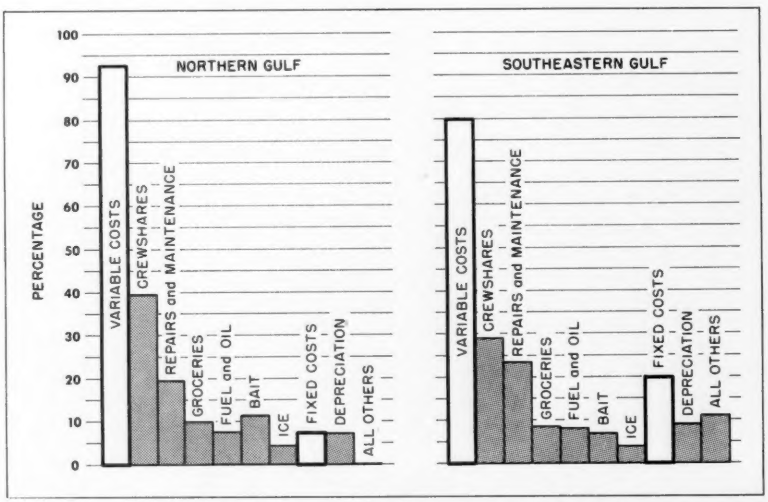


Figure 4.—Comparison of variable and fixed costs by type for large (56-69 feet) red snapper-grouper vessels operating in the northern and southeastern Gulf of Mexico, 1974 and 1975.

Total fixed costs will remain the same regardless of the level of fishing effort. The summation of variable and fixed costs represents total production cost. Variable, fixed, and total costs for both sizes of vessels in each area are given in Table 5 and shown in Figures 3 and 4.

Variable Costs

Variable costs represent the largest proportion of total costs for all four groups of vessels. These range from 80 percent of total costs for the large southeastern vessels to 92.6 percent of total costs for the large northern vessels. Variable costs represented about 85 percent of total costs for both groups of small vessels. The small southeastern and northern vessels incurred variable costs of $22,085 and $17,213, respectively. The large northern vessels variable costs ($48,679) were more than double that of the other three groups.

Crew shares. Crew wages or shares[7] represent the largest variable cost for all vessel classes except the small southeastern vessels. Crew shares ranged from as high as 39.7 percent ($20,865) of total costs for the large northern vessels to a low of 21.4 percent ($4,299) of total costs for the small southeastern vessels. Average share per crewman is the total net share to all crewmen on each vessel divided by the average number of crewmen aboard. The small vessels average 1.3 and 1.1 crewmen (excluding captain) per trip with average shares for each crewman equal to $7,263 and $3,908 in the northern and southeastern vessels, respectively. Average individual crew shares for the large vessels were $5,639 (3.7 crewmen per trip) and $4,034 (2 crewmen per trip) for the northern and southeastern gulf vessels, respectively[8]. Crew share variation occurs more between areas than between vessel size. Since crewmen are paid a share of the gross stock, northern vessel crewmen receive higher shares because their catches have a higher percentage of more valuable red snapper. Total catch was also much higher for the large northern vessels.

Repairs and Maintenance. Repairs and maintenance are the second largest variable expense item (17.5 to 23.5 percent of total) for three vessel classes and the largest expense item (31.6 percent of total) for the small southeastern vessels. Repairs and maintenance costs include hull, engine, tackle, and equipment maintenance. Repairs and

[7]Crewmen are generally paid on a share basis which varies among vessels. Often, such expenses as ice, bait, groceries, and fuel are deducted from the gross stock. Then the boat, the captain, and individual crewmen share the remaining stock on a prearranged percentage basis. Sometimes crewmen are paid a bonus for performing cooking or icing duties while at sea. The captain may also receive a bonus depending on the species composition of the catch. Crewmen received payment on a piece rate basis on 3 of the 20 vessels in the sample. In these cases their share of the gross stock is determined to be their individual catch multiplied by a specific price per pound which ranged from 25 to 50 percent of market price. In most cases these crewmen also shared in a small part of total expenses.

[8]Crewmen often vary on a trip basis. Crew wages may not be representative of a crewman's total annual income.

maintenance costs were about the same ($6,349 as compared with $6,511) for both the large and small southeastern vessels but much lower total costs of operation for the small vessels made the percentage much higher. Repair and maintenance costs for the small northern vessels were $4,565 and $10,278 for the large northern vessels[9].

Other Variable Costs. Fuel and oil, groceries, and bait were almost of equal importance in terms of cost. For all four vessel classes each of these three individual cost categories range from a low of 6.9 percent of total cost to a high of 11.3 percent. Normally, groceries are the highest of the three while bait is the lowest. The exceptions were bait for the small southeastern vessels and the large northern vessels. Ice represented 3.9 to 4.5 percent of total cost.

Fixed Costs

Fixed costs as a percent of total cost varied significantly among the four vessel classes ranging from a low of 7.4 percent ($3,897) for the large northern vessel to 20.0 percent ($5,537) for the large southeastern vessels. The percentage was about the same (15.1 compared with 14.4) for the small vessels.

Depreciation. Hull, engine, and equipment depreciation was higher for large northern vessels in total dollars ($3,842) than other vessels, although as a percentage of total cost it was the lowest cost item. Two vessels in this class were constructed of steel with longer life expectancies and higher salvage values. However, part of the greater life expectancy and greater salvage values can be attributed to the difference in expenditures for maintenance discussed earlier. All but one vessel in each of the small northern vessels class and large southeastern vessels class were constructed of wood. Average annual depreciation costs were about equal. Vessels were depreciated over a 10-year period. The lowest depreciation was experienced for the small southeastern vessels at $1,875. One vessel in each of the southeastern vessel classes was older than its taxable depreciation life and no depreciation value was assigned these vessels. This caused the average depreciation to be lower for these classes. Depreciation for those vessel classes excluding these vessels would have been $2,250 and $3,300 for the small and large southeastern vessels, respectively. Average current value of investment in each vessel class is shown in Table 6 and Figure 5.

[9]Hull construction data for each vessel class are given in Table 1.

Table 6.—Annual net returns to captains and owners for Gulf of Mexico commercial red snapper-grouper fishing vessels by vessel size and production areas, 1974 and 1975.[1]

	38 feet to 47 feet (small)		56 feet to 69 feet (large)	
Item	Northern gulf	Southeastern gulf	Northern gulf	Southeastern gulf
	Dollars			
Total investment	26,526	34,167	67,267	56,250
Total revenue	41,357	30,384	97,030	33,548
Total cost	26,026	20,103	52,576	27,707
Net returns to captain and owner	15,331	10,281	44,454	7,841
Net to captain[2]	6,286	6,168	18,226	5,392
Net to investment[3]	2,122	2,733	5,381	4,500
Net to owners labor and management[4]	6,923	1,380	20,847	−2,051

[1]Based on Table 5.
[2]The captain's share was determined by different methods for several boats. The net captain's share for each vessel for the southeastern area was determined as if the captain was not the vessel owner. The average net captain's share was then determined. The captain's share for the northern gulf area was based on an average of seven vessels where the captain and owner were not the same person and was estimated to be 41 percent of the total net returns.
[3]Net to investment is an imputed return to capital investment at an assumed market rate of 8 percent.
[4]Net returns to owner's labor and management reflect payment for the owner's labor and management. Specific functions include rigging and supervising the maintenance of vessels, procurement of labor and supplies, marketing and office duties such as accounting and personnel management.

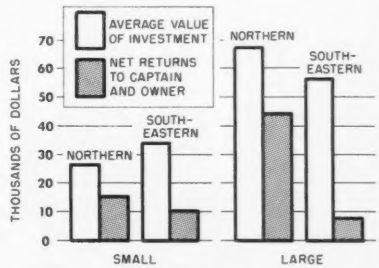


Figure 5.—Average level of investment in vessels and gear and net returns to captain and owner for small (38-47 feet) and large (56-69 feet) red snapper-grouper vessels operating in the northern and southeastern Gulf of Mexico, 1974 and 1975.

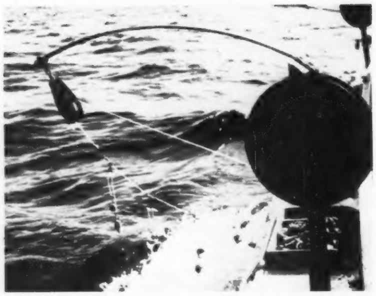
Other Fixed Costs. Remaining fixed cost categories were payments for vessel licenses (boat registration), interest on loans, insurance, and docking fees. Owners of the large northern vessels carried their own risk and provided their own financing and thus incurred no expenses for these items. Vessels in the northern gulf paid no docking fees. In those cases where insurance was carried the normal range was 3 to 4 percent of the insured hull value. Since all vessels were not insured in each of the classes, the average insurance cost per vessel shown here is low. The same comment would hold true for interest since some vessels had no mortgages and thus no interest was paid.

Total Costs

Total costs were the lowest for the small southeastern vessels, $20,103. In increasing order total costs for the remaining three classes were $26,026 (small northern vessels), $27,707 (large southeastern vessels), and $52,576 (large northern vessels). The increased value of the catch for the northern vessels more than offsets the higher costs and makes this vessel class the most profitable from the point of net returns.

Net Returns

Total net returns to the captain and owner of the large northern vessels was $44,454 per year (Table 6 and Fig. 5). This level of returns was almost three times greater than that of any of the other three classes. Net returns for individual vessels in this class ranged from $37,077 to $68,794. Average net return



This type of reel is used for snapper and grouper fishing in the Gulf of Mexico. Reels are powered by either a large crank manually operated (sometimes called a one-armed-bandit) or a small electric motor. As many as 12 hooks are sometimes used on the terminal end of each gear.

to the captain was $18,226 with one captain earning as high as $28,205. Vessels in this group were owned by individuals other than the captain. The average captain's share was 41 percent of the total net returns to captain and vessel owner.

The next most profitable class was the small northern vessels with a net return to captain and owner of $15,331 with one vessel ranging as high as $29,524. Net to the captain on these vessels was $6,286 with a range of $3,307 to $12,104.

Southeastern vessels had net returns to the captain and owner of $10,281 and $7,841 for the small and large vessels, respectively. Net returns for the small vessels ranged from $528 to $16,999. One large vessel in the southeast showed a small loss and the most profitable had a net return of $14,340. Average net returns to captains of small vessels was $6,168 (with a high of $11,040) while captains of large vessels earned an average of $5,392 (with a high of $6,011).

Net return to investment reflects the amount the owners could earn on the capital they have invested in the firm by investing in outside activities such as the financial market. Capital investments per vessel ranged from $26,526 for the small northern vessels to $67,267 for the large northern vessels. Investment levels for the small and large southeastern vessels were $34,167 and $56,250, respectively. Net return to investment was calculated at 8 percent.

The residual of net return to captain and owner after allowing for the captain's share and return to investment is the return to the owner's labor and management. Specific owner activities include boat maintenance, marketing, personnel, and business management. The net return to owners labor and management for the four classes ranged from a loss of $2,051 for the large southeastern vessels to a gain of $20,847 for the large northern vessels.

INDUSTRY IMPLICATIONS

Captains and owners of fishing vessels are more aware of the profit potential of their individual fishing firms than anyone. Each has the option of purchasing the size of vessel that he chooses and of making the determination of where that vessel fishes. Perhaps foremost in this decision (not ignoring safety and physical production characteristics of the vessel) should be the ability of the vessel to produce an acceptable economic return to the captain and owner. This paper has attempted to demonstrate the importance of the size and production area characteristics of the northern and southeastern Gulf of Mexico red snapper and grouper fishery. Any captain or owner contemplating a change in vessel size or changes in production area should be aware of the importance of each in this fishery.

Just because one vessel is larger than another doesn't mean that vessel will provide a larger net return to the owner. This was illustrated in this paper where larger southeastern Gulf of Mexico vessels had no significantly larger net returns than smaller vessels docked in the same area. This occurred because their costs were relatively lower than the larger vessels although the larger vessels had higher total revenues.

The importance of the production or fishing area also was demonstrated. Both small and large vessels in the northern gulf and higher net returns than the southeastern gulf vessels (only larger were statistically significant). This was due primarily because the catch composition of the northern gulf boats was weighted predominately toward the higher valued red snapper as compared with grouper-predominated catches of the southeastern vessels. The large northern gulf vessels with almost exclusively red snapper catches showed net returns to the captain and owner about triple that of captains for the other three vessel classes. Although costs were approximately double that of the other three vessel classes, the owners' labor and management for the large northern vessels ($20,847) was three times that of the small northern vessels ($6,923) and 15 times that of the small southeastern vessels ($1,380) while the large southeastern vessels showed a loss for the owners' labor and management. Large vessels (particularly in the northern gulf) are usually owned by multivessel firms which require an office staff. Salaries for the staff are paid from the net returns to the owner. The relatively large net return to ownership of the large vessels also reflects the fact that the owners of these vessels carry all of their own insurance, risk, and provide the required capital.

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MFR PAPER 1270

Loggerhead Sea Turtles, *Caretta caretta*, Encountering Shrimp Trawls

LARRY H. OGREN, JOHN W. WATSON, Jr., and DONALD A. WICKHAM

ABSTRACT—The behavior of three loggerhead sea turtles, Caretta caretta, *was observed by scuba divers during trawl operations. One turtle avoided trawl capture, but two did not. Before capture, the two turtles tried to outdistance the trawl but eventually tired and were overtaken and became entangled in the trawl's webbing. Suggestions are given for modifications of trawls to stop turtle capture.*

INTRODUCTION

The accidental capture of sea turtles by commercial fishermen occurs primarily along the Atlantic and Gulf of Mexico coasts of the United States. Shrimp trawls are the most frequently involved gear, and the loggerhead, *Caretta caretta*, and Atlantic ridley, *Lepidochelys kempi*, are the most frequently caught sea turtles (Liner, 1954; Caldwell et al., 1959; Caldwell, 1960; Chavez, 1969). The leatherback, *Dermochelys coriacea*, and green, *Chelonia mydas*, sea turtles have been caught in trawls, but less frequently (Ogren, unpubl. notes; Schwartz, 1954; Yerger, 1965).

The magnitude of accidental catches and the mortality rate of captured turtles by trawls are unknown. William W. Anderson stated that captures of loggerhead sea turtles off Georgia by shrimp fishermen once were frequent enough to be a nuisance (Caldwell et al., 1959). Net damage by turtles and loss of fishing time reduces the efficiency of the trawlers, as well as the loss of that portion of the catch crushed by turtles. In recent years, most strandings of dead sea turtles on coastal beaches adjacent to waters that are heavily fished have been attributed to shrimp trawlers.

Caldwell (1963) believed that half, or fewer, of the turtles caught in trawls survive. Those caught usually drown because they are held underwater too long. Shrimp fishermen have resuscitated some comatose turtles by placing them on their backs and pumping on their plastron, and some have survived when they were placed on their backs and occasionally wetted down. However, they should not be exposed to direct sunlight for long periods. If unconscious turtles were to be put overboard they would probably drown.

Although the capture of sea turtles in shrimp trawls is an accidental catch problem, as long as mortalities occur, conflicts between commercial fishermen and turtle conservationists will continue. Protection of critical nesting habitat along coastal beaches and reduction of mortalities at sea are needed for the conservation of sea turtles.

National Marine Fisheries Service, NOAA, scuba divers of the Southeast Fisheries Center laboratories at Pascagoula, Miss., and Panama City, Fla., observed the behavior of adult loggerhead sea turtles during encounters with experimental shrimp trawls. These observations and subsequent discussion are presented here to aid in designing trawls to stop the capture of sea turtles.

OBSERVATIONS

Turtle behavior was observed during October 1973 and 1974 in the waters off Panama City, Fla., by scuba diver/scientists using techniques similar to those described by Wickham and Watson (1976) to evaluate towing characteristics of trawls.

Successful Trawl Avoidance

This observation was made in 9 m of water by divers riding the headrope of an experimental 15-m (headrope length) semiballoon shrimp trawl being towed at about 2.5 knots by the RV *George M. Bowers*. A loggerhead turtle, about 1.2 m carapace length, was encountered approximately 1 m above the bottom, swimming leisurely in the same direction the trawl was being towed. When the trawl doors passed and the net began to overtake the turtle, its swimming speed increased until it equalled the speed of the trawl. The turtle remained oriented in the same direction as the trawl but increased its speed further by beginning to make powerful sweeps with its front flippers, swimming with a pulsated lunging motion. As the turtle began to outdistance the trawl, it moved at an angle toward the left side of the trawl, passed in front of the port door and out of the path of the trawl. This encounter lasted approximately 2-3 minutes.

Unsuccessful Trawl Avoidance

This observation was made under conditions similar to the preceding encounter. A loggerhead turtle, about 1.2

Larry H. Ogren is with the Panama City Laboratory, Southeast Fisheries Center, National Marine Fisheries Service, NOAA, P.O. Box 4218, Panama City, FL 32401. John W. Watson, Jr., is with the Pascagoula Laboratory, Southeast Fisheries Center, National Marine Fisheries Service, NOAA, P.O. Drawer 1207, Pascagoula, MS 39567. Donald A. Wickham is with the Plans and Policy Staff, National Marine Fisheries Service, NOAA, Page Building 2, 3300 Whitehaven Street N.W., Washington, DC 20235. This paper is Contribution No. 77-14PC from the Panama City Laboratory, Southeast Fisheries Center, National Marine Fisheries Service, NOAA.

m in carapace length, was swimming approximately 1 m above the bottom in the direction of the tow near the starboard side of the trawl. Its first reaction to the trawl was to swim ahead of the trawl with powerful strokes of its flippers (Fig. 1). The turtle kept just ahead or even with the net headrope and did not attempt to turn left or right. The turtle's swimming stroke slowed after 2 or 3 minutes, and the trawl began to overtake it. Then the trawl headrope passed over the turtle, and as the tapering sides of the trawl approached, the turtle increased its swimming effort. The turtle swam forward in the trawl about 2-3 m to the headrope, rested momentarily, and then was overtaken by the net. At times, the turtle pushed against the trawl with its flippers, occasionally getting its claws and outer shell scutes snagged in the webbing. This pattern of increased swimming effort—moving forward to the net headrope, swimming up against the top of the net, momentarily resting and then being overtaken by the net—was repeated for 8-10 minutes until the turtle finally was swept against the tapering side of the trawl near the top panel. At this point, the turtle appeared to be extremely fatigued but attempted to escape through the top of the trawl by clawing and biting at the webbing. It was then swept further back into the trawl, coming to rest on the right side of the net just ahead of the cod end section and made no further effort to escape (Fig. 2). The divers then cut the webbing and removed the turtle from the trawl. The turtle offered no resistance, but the divers had difficulty removing it because the scutes and claws were entangled in the webbing. The turtle surfaced immediately and was observed blowing heavily on the surface of the water.

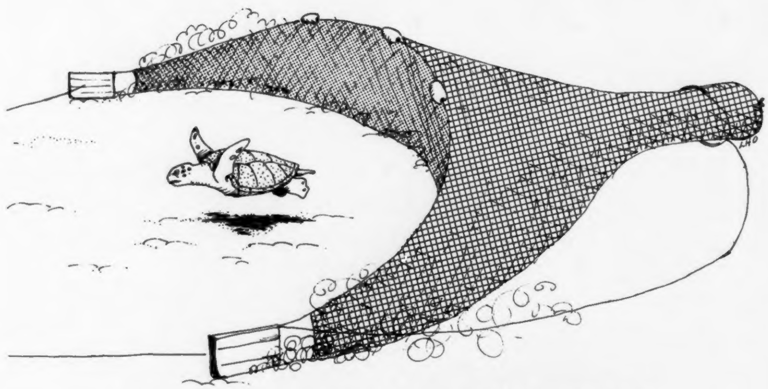

Figure 1.—Sea turtle attempting to escape trawl by outswimming it.

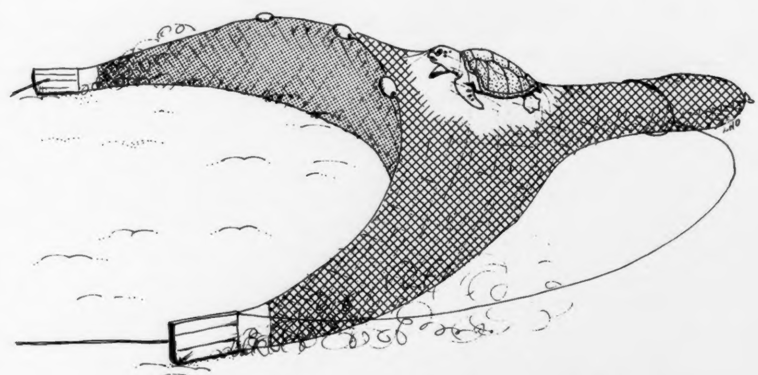

Figure 2.—Exhausted sea turtle caught in trawl and entangled in meshes.

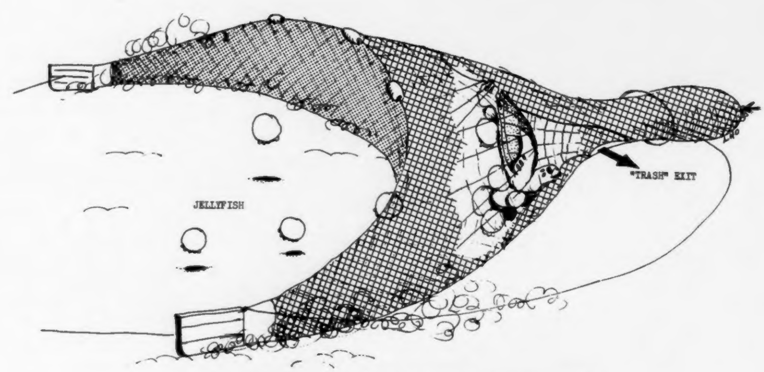

Figure 3.—Sea turtle in trash chute of separator trawl.

Entanglement in Separator Trawl

This observation was made during the evaluation of an experimental shrimp trawl with a 15-m headrope and a separator panel of large mesh size. The separator panel narrowed into a trash chute which led to an opening in the bottom. The trawl was towed in 9-12 m of water at a speed of approximately 2 knots by the University of Georgia's *Capt. Gene*. When the divers reached the net, approximately 20 minutes after it was set, a female loggerhead turtle about 1.2 m in carapace length was trapped in the narrow part of the inner trawl ahead of the trash chute (Fig. 3). The turtle was

oriented vertically, head down, forming a plug in the trash chute, with its scutes and parts of its flippers tangled in the webbing. Jellyfish, electric rays, and other fish were accumulating in the body of the trawl ahead of the turtle. The turtle was still alive, but it was completely immobilized by the water pressure and webbing. The divers cut through the inner and outer webbing and released the turtle from the trawl—it was soon observed blowing at the surface astern of the trawler.

DISCUSSION

The reactions of turtles when encountering a trawl enhances the probability of their capture and entanglement in the trawl, with drowning if they are held submerged for an extended time. Even though turtles attempt to escape trawls by outswimming them, this maneuver is seldom successful because they cannot maintain maximum swimming speed for a sufficient period. Further, turtles encountering trawls at night or in turbid water probably do not detect the approaching trawl until they are within the net.

Some turtles can escape capture if they detect the trawl early enough and their swimming carries them out of the path of the trawl, either to one side or up to a sufficient elevation for the trawl to pass under them. One of the observed turtles, however, did not turn away from the towing direction of the trawl, but persisted in swimming directly ahead of the trawl near the bottom, turning neither right nor left, nor attempting to surface. This might be a negative response to the trawl doors, especially if the water was clear enough for it to be a visual stimulus. The large trawl doors, looming to the right and the left of the turtle's escape path, plus the turbidity clouds stirred up by the heavy metal shoes on the doors, may have guided the turtle straight ahead of the trawl. In highly turbid waters, noise from the strumming of the cables or chains striking the doors might also be important cues. At night, phosphorescence, produced by the movement of the gear through the water, may be another factor in turtle response to trawls.

The turtle that escaped the trawl did not make an overt maneuver to avoid the net but swam at a slight angle to the tow direction, which resulted in its moving out of the trawl path. It appears that the reactions of turtles encountering trawls make their capture highly probable and that these reactions are similar to those observed for fishes. Since the strenuous effort of attempting to outswim the trawl or to escape through the webbing causes an increase in oxygen consumption, drowning of the turtle is likely, especially if the duration of the tow is long.

It has been suggested that separator trawls, designed to eliminate jellyfish or noncommercial fish species through an exit chute or simply through a hole cut in the bottom panel, would allow turtles to escape. It is doubtful if this type of gear would be successful in eliminating sea turtles because their peripheral scutes, flippers and claws, and encrusting organisms become entangled in the webbing. However, juvenile turtles may pass unhindered through this kind of trawl, but some shrimp loss would also occur. Neonate or "hatchling" sea turtles are seldom encountered by trawls because they do not swim or dive deeply below the surface. The intense locomotor activity associated with the neonate's seaward goal away from its natal beach and subsequent epipelagic habits may explain their absence in catches of trawlers that fish adjacent to nesting beaches and offshore.

Perhaps the best method to prevent turtles from entering the trawl would be to place an excluder panel of large mesh webbing or other suitable material across the mouth of the net, extending from wing to wing and headrope to a footrope attached to the doors. Because the turtle's behavior consists of swimming directly ahead of the trawl, apparently guided by the gear, this type of modification might be successful in leading the turtle away from the mouth of the net and out of its path. It is believed that this trawl design would have little or no effect on the shrimp catch.

ACKNOWLEDGMENTS

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MFR PAPER 1271

Importance of Eelgrass Beds in Puget Sound

GORDON W. THAYER and RONALD C. PHILLIPS

Seagrasses, grass-like flowering plants in marine environments (Fig. 1), inhabit intertidal and comparatively shallow subtidal regions of estuaries and the nearshore coastal zone, and support rather characteristic animal assemblages regardless of the particular geographic location or species composition. There are few parts of the world's coastal zone where one or more of the 48 species of seagrasses have not adapted. Seagrasses are one of the most common coastal ecosystem types, and generally are quite conspicuous for they tend to form extensive submerged meadows or beds on bottoms ranging from coarse sand to almost liquid mud.

Eelgrass, *Zostera marina*, which occurs extensively in Puget Sound, is a generally temperate (cool water) seagrass which has a very extensive geographic range. About 9 percent or over 125,000 acres of the bottom of Puget Sound is covered by eelgrass. On the Pacific coast this seagrass extends from Alaska to Mexico and on the Atlantic coast from Greenland to North Carolina. This grass also is present along the coasts of the British Isles, Europe, and Asia. The importance of eelgrass and seagrasses in general is not fully understood, and this knowledge is essential because their shallow water and intertidal existence often results in a conflict between their success and man's use of the coastal environment.

Figure 1.—Underwater photograph of an eelgrass meadow in Puget Sound. Photo by R. C. Phillips.

Documentation now exists which shows that seagrass meadows are not only important locally but also on a much larger scale. Phillips (1975) has summarized many of these findings. Examples include their use as nursery grounds for commercial shrimp in Florida; as a food source for migratory waterfowl, particularly the black brant, along the Pacific flyway, milkfish throughout the Indo-West Pacific, and green sea turtles in the Caribbean; as a habitat for the larval development and growth of commercial bay scallops along the Atlantic coast of the United States and fishes along all coasts where the grass is present; and as a buffer from hurricanes on the Florida coast.

In addition, Thayer et al. (1975) summarized examples of the impact of seagrass destruction on animals. For example, at Cape Ann, Mass., there was a severe decline in softshell and razor clams, lobsters, and mud crabs following the decline of eelgrass in the 1930's. However, declines in fisheries in the North Atlantic were not as drastic as had been predicted following the eelgrass catastrophy of the same period.

These observations and research efforts, primarily since the late 1960's, have shown that the importance of eelgrass systems does not necessarily lie in their direct food value to organisms but in their multifaceted functions. These functions are both obvious and subtle. Two of the obvious are that they provide a habitat for the growth of both

Gordon W. Thayer is leader of the Estuarine and Nearshore Coastal Ecosystems Task, Ecology Division, Beaufort Laboratory, Southeast Fisheries Center, National Marine Fisheries Service, NOAA, Beaufort, NC 28516. Ronald C. Phillips is a professor of biology at Seattle Pacific University, Seattle, WA 98119.

commercial and noncommercial, but ecologically important, fish and invertebrates, and that because of their normally dense growth, seagrasses also provide small organisms a significant degree of protection from predators.

Less obvious but nevertheless equally significant are the facts that: 1) eelgrass leaves have a high rate of growth and although few organisms feed directly on the leaves, the major food chains are based on detritus (dead material) derived from the leaves; 2) detritus exported from these grass meadows may support food chains in adjacent waters; 3) the blades support many small epiphytic (biota growing on plants) organisms which are used as food sources by many invertebrates and fish; 4) the roots bind the sediments protecting the bottom from erosion, while the leaves slow currents and increase the rate of deposition of fine sediments and organic matter; and 5) the plant roots remove nutrients, e.g. nitrogen and phosphorus, from the substrate and transfer them to the leaves and then to the surrounding water, thus providing nutrients for other plants (McRoy and Barsdate, 1970; McRoy and Goering, 1974). Eelgrass also has been used as fodder, fuel, fertilizer, and insulation.

The animals inhabiting and using eelgrass beds in Puget Sound are not well documented, although some descriptions are available in Phillips (1972) and Kozloff (1973). There are, however, general relations existing between eelgrass meadows and their invertebrate and vertebrate fauna on the Pacific and Atlantic coasts of the United States and elsewhere that can be applied to the eelgrass communities of Puget Sound. In addition, invertebrate classes at Seattle Pacific University and the University of Washington and R. C. Phillips have made collections of organisms in Puget Sound eelgrass beds. The Washington State Department of Fisheries and the Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, Wash., also have information available on commercial and sport fishery organisms in Puget Sound. Where possible, we will use species from these collections and records (Tables 1 and 2) in describing the relationships existing between the plant and its fauna in Puget Sound.

Table 1.—Partial list of invertebrates commonly collected in eelgrass beds in Puget Sound.

Taxonomic group	Representative genera	Common name	Comment on habitat
Porifera		Sponges	
	Haliclona		Both generally on substrate
	Lissondendoryx		
Coelenterata		Polyps	
	Epiactis	Anemone	On blades
	Haliclystus	Stalked jellyfish	On blades
	Gonionemus	Jellyfish	On blades in deep water
Platyhelminthes		Flatworms	
	Freemania		On blades
Nemertea		Ribbon worms	
	Micrura		On blades and inside spathes
	Carinella		
Annelida		Segmented worms	
	Glycera	Beak thrower	Substrate
	Nereis	Nereid worm	Near base of blades and around roots
	Thelepus	Terebellid worm	Substrate
Arthropoda		Jointed animals	
	Ampelisca	Amphipod	On blades
	Amphithöe	Amphipod	On blades
	Idotea	Isopod	On blades
	Pandalus	Coon-stripe shrimp	On and around blades
	Crangon	Snapping shrimp	Around roots
	Pagettia	Spider crab	On substrate
	Cancer	Dungeness and red crabs	On substrate
	Pagurus	Hermit crab	On substrate
Pelecypoda		Bivalves	
	Pecten	Scallop	On and in substrate but small forms often on blades
	Clinocardium	Cockle	
	Macoma	White sand and bent nose *Macoma*	
	Panope	Geoduck	On and in substrate
	Mya	Soft-shell or steamer clam	
Gastropoda		Snails and slugs	
	Littorina	Periwinkle	All are found on blades as well as on and in the substrate
	Haminaea	Bubble shell	
	Lacuna	Variegated *Lacuna*	
	Hermissenda	Sea slug	
	Anisodoris	Sea slug	
	Acmaea	Limpet	On blades
Echinodermata		Sea stars, brittle stars, sea urchins, sea lilies, sea cucumbers	
	Leptoasterias	Starfish	All are found on the substrate but small forms often on blades
	Solaster	Sun star	
	Stronglyocentrotus	Sea urchin	
	Dendraster	Sand dollar	
	Cucumaria	Sea cucumber	On substrate
Bryozoa		Moss animals	
	Membranipora		On blades

Table 2.—Organisms found in or utilizing eelgrass beds in Puget Sound which are of commercial or recreational importance.

Crustaceans	Fishes
Coon-stripe shrimp	Pacific herring
Broken-back shrimp	English sole
Dungeness crab	Striped seaperch
	Coho salmon (fingerlings)
Mollusks	
Geoduck clam	
Soft-shell steamer clam	Birds
Washington butter clam	Black brant

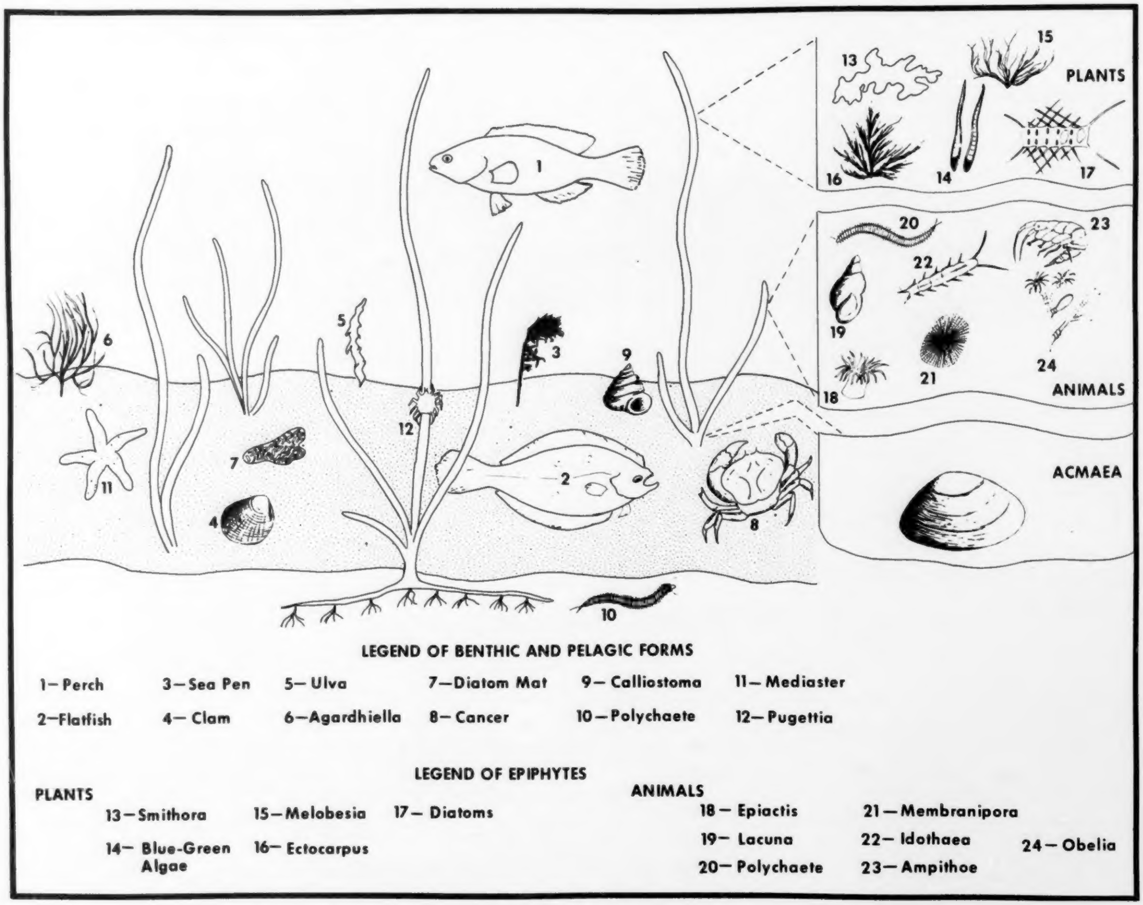

Figure 2.—Diagram of an eelgrass community showing some of the more conspicuous associated organisms in Puget Sound.

Although the specific organisms associated with eelgrass meadows vary from geographic area to geographic area and, indeed, even within a local seagrass system, the fundamental structure of animal communities of eelgrass beds is similar. There also is a striking similarity in the taxonomic structure of these communities. Characteristic organisms or types are found on the blades of the plants, around the bases of the plants, and around the roots (Fig. 2). In addition, numerous larger algae are found attached to the eelgrass blades and floating free within the beds. These algae increase the surface area and available hiding places so that more animals can be supported. In fact, the scientific literature indicates that the number of species and the abundance of organisms generally are greater than those of adjacent areas devoid of eelgrass.

The great variety of organisms and the richness of the animal populations in part are a response to the presence of a variety of habitats and food sources within the grass meadows. The animal associations of eelgrass beds in Puget Sound and throughout the world generally can be considered as having several major vertical layers or strata of organization: animals living on the blades and stems, those swimming among the plants, and those living on and in the bottom.

Those organisms living on the blades may have a close correlation with the bed and may not be found, or are found in significantly smaller numbers in regions devoid of the grass. Some of the animals living on or in the bottom, on the other hand, may be a part of the benthic community of adjacent bare substrates. Of the mobile, swimming organisms, some may be members of the grass bed, some are only seasonal migrants into the bed, and still others use the beds for food and protection, moving into the areas at high tide and at night. Representatives of these categories in Puget Sound are listed in Table 1.

The first category, the fauna living

on the leaves and on and within the coating of diatoms, encrusting algae, and bacteria on the leaves, is very diverse. As a group, these animals derive their nutrition from microalgae, detritus (dead matter), and small animals. They in turn are fed upon by larger animals. This category, for ease of presentation, can be further subdivided into five groups.

1) Small organisms living in and on the epiphytic coating. This group is probably the most diverse and least known or understood component of seagrass beds. It is made up of herbivores (animals feeding on living plants), detritivores (animals feeding on detritus plus the microbes growing on the detritus), and carnivore members of the protozoans (ciliates, flagellates, and foraminiferans), free living nematodes (unsegmented worms), small polychaetes such as *Nereis,* and small crustaceans.

2) Sessile or attached fauna. In Puget Sound there are encrusting bryozoans such as *Membranipora* and attached bryozoans (Fig. 2), anemones (*Epiactis*), and attached jellyfish (*Haliclystus* and *Gonionemus*). These organisms generally feed on small crustaceans, larval fish, and detritus. Barnacles and different life history stages of larger animals often are found attached to the plant leaves. For example, the Pacific herring lays eggs on eelgrass leaves and young scallops, and other bivalves also are often attached to the leaves.

3) Organisms which move over the blades. The most noticeable members of this group in Puget Sound are listed in Table 1, and are represented by snails, polychaetes, ribbon worms, amphipods, isopods, and some echinoderms (starfish and urchins primarily).

4) Swimming animals able to rest on the leaves. Some species of shrimps, small crabs, and certain fish are common members of this group.

5) Animals attached to stems and roots. This subcategory is represented by tube-building polychaetes and amphipods.

The second major category, the mobile animals swimming among and under the leaves, is more easily recognizable because of their larger size. As mentioned earlier, these organisms may be permanent, seasonal, or only occasional residents of eelgrass beds. For the most part, the members of this category are carnivores, feeding on detritivores; they also may feed on detritus. Because they are carnivores, their seasonal and daily movements into and out of eelgrass beds may significantly influence the trophic (nutritional) structure of the beds. Representatives of this category in Puget Sound are the decapod crustaceans (shrimps and crabs) belonging to the genera *Pandalus, Pagettia, Cancer,* and *Pagurus* (Table 1), and numerous species of fish. For the fish, the eelgrass beds form significant nursery grounds and common forms generally are larval and juvenile stages although adults of some species are quite common.

Several of the commercially important fish harvested in Puget Sound (Table 2) are members of this category, and are found in, and are partially dependent upon, eelgrass during part of their life history development. The broken-back shrimp, *Heptacarpus,* and the coon-stripe shrimp, *Pandalus,* although found elsewhere within the Sound, are collected in significant numbers in the grass beds. The Dungeness crab, *Cancer magister,* generally taken by traps on sandy bottoms in relatively deep water, also can be found at low tide in sandy and muddy regions of the Sound where there is a good growth of eelgrass.

The most common commercial species dependent on the Sound's eelgrass beds are the Pacific herring, English sole, striped seaperch, and the silver salmon. These fishes not only feed in the grass meadows on epifauna and crustaceans, but also use the beds as nursery areas. The Pacific herring enters the eelgrass areas in winter and spring to spawn and its eggs become attached to the grass blades. It is a prime baitfish for salmon, and its roe is sold on the open markets. The English sole, the most important demersal fish in Puget Sound, and the striped seaperch are collected by commercial trawlers and by sport fishermen using spears and hook and line in or near grass beds. The fingerling stage of the silver salmon, an important commercial species in Puget Sound, feeds on the animals living on eelgrass blades.

The third category, those organisms living in and on the bottom, contains members of the sponges, polychaetes, crustaceans, mollusks, and echinoderms (Table 1). The majority of these organisms appear dependent on eelgrass detritus as a major food source although microalgae and small crustaceans may also be consumed. Members of this category are not necessarily endemic to eelgrass beds but usually are an extension of the benthic community of adjacent bare substrates. Commercially important organisms belonging to this category are the large geoduck clam, *Panope,* the steamer or soft-shell clam, *Mya,* and the Washington butter clam, *Saxidomus.*

Animals may overlap between these three major organizational categories, especially at different stages of their life cycles.

Although not normally considered members of the eelgrass community, several species of waterfowl feed extensively in the beds of Puget Sound. Most common are the black brant and scaup, both of which feed on the grass blades. It has been estimated that eelgrass constitutes about 80 percent of the winter food of the black brant. Cottam (1934), and McRoy (1966) calculated that black brant and Canada geese consume about 17 percent of the standing crop of eelgrass in Izembek Lagoon during summer and fall. When nearly all of the eelgrass disappeared along most of the U.S. coastline in the 1930's, the brant all but disappeared. Both the brant and the scaup are extensively hunted and thus, provide a significant source of revenue to the State of Washington.

The animal components of all of the strata are linked together by trophic (nutritional) relationships. These relationships plus the great variety of organisms and habitats within eelgrass beds result in a complex ecosystem which functions primarily through herbivore and detritivore food webs. The herbivore food chains generally are short, while the detrital chain normally

is long and complex. By far the predominant food pathways in these meadows are: eelgrass → detritus (plus attendant microbes) → detritivores, and eelgrass → detritus (plus attendant microbes) → detritivores → carnivores (e.g. some crabs, fish, birds, and man).

There are few organisms which feed directly on the living grass blades and, therefore, most of the plant materials produced within the bed falls to the substrate and is decomposed by bacteria. Most of the plant material is used by animals as partially decomposed matter, either suspended in the water or deposited in or on the bottom. Different stages of decomposition of the material may correspond to different detrital feeding organisms. For example, some urchins, crustaceans, and fish may feed on large plant pieces, while some mollusks and polychaetes may feed on fine plant detritus. In addition, detritus derived from the decomposition of eelgrass in Puget Sound is transported into the nongrassed areas of the Sound and into the coastal marine environment by waves and tides. Here it may form an important energy source for organisms inhabiting these areas.

Within the eelgrass meadow there are seasonal changes both in the grass itself and in the fauna associated with the system. Although eelgrass is a perennial plant, its abundance varies seasonally. In Puget Sound the density of eelgrass tends to increase in spring and summer and decrease in fall and winter. Data exist which indicate that as the grass increases in density during spring and summer, the blades of the plant become more highly colonized by microscopic plants and animals (Kozloff, 1973).

During this period there often is a conspicuous increase in animals which feed on the epiphytes or detritus on the grass blades. On the other hand, several studies indicate that detritivores and filter feeding animals tend to increase during the period of eelgrass decay. It also has been observed that minute flagellates often increase during the decay season, and that breeding season of several macroinvertebrate species coincides with this flagellate increase. The adults and their larvae feed on the flagellates and fine suspended matter.

Thus, the abundance and types of animals in seagrass meadows appear to be integrally linked with each other and with the abundance and stage of development or decay of the grass. The leaves support a myriad of organisms, many of which go unnoticed because they are (or nearly are) microscopic. These, in turn, support larger organisms of both ecological and commercial importance. The detritus produced within the meadows is transported to open waters of the Sound and nearshore coastal environment where it may provide an important energy source for open-water animals. Animals which feed in the beds and migrate elsewhere also link the beds to the open water environment for they excrete material which is used by microorganisms of these environments and they themselves may serve as food sources for larger animals inhabiting open waters.

Therefore, to fully appreciate the overall significance of eelgrass meadows in Puget Sound and elsewhere, the proportionate role that eelgrass plays in the energetic scheme of all estuarine and coastal productivity must be considered. The marine fishery and sport fishery organisms used by man ultimately depend on this productivity. Within the United States, the International Decade of Ocean Exploration of the National Science Foundation is funding a coordinated study of seagrass ecosystems. Both authors are members of this team, which has as one of its objectives the understanding of the role of seagrass ecosystems as natural resources of value to man, not just at the scientific level but also by individuals and organizations directly concerned with the management of our natural resources.

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NOAA REORGANIZES

Secretary of Commerce Juanita M. Kreps has announced approval of a plan to reorganize the National Oceanic and Atmospheric Administration.

The plan, recommended by NOAA Administrator Richard A. Frank, is designed to equip the agency to meet new and growing responsibilities for ocean use and resource management and climate and weather modification. A major realignment of administrative duties is being undertaken, and several new offices are being added. The plan was submitted to the President's Reorganization Project and to the House and Senate Appropriations Committees for review. It was to go into effect 1 October 1977.

NOAA was created in 1970 to perform a wide variety of oceanic and atmospheric functions. Since, Congress has specifically given NOAA responsibility for management, regulation, and protection of fisheries in the 200-mile off-shore zone; protection of whales, porpoises, and other marine mammals and endangered species; assistance to states to manage their coastal land and water; various aspects of ocean dumping, environmental assessment, deepwater port, and marine sanctuary programs. In the atmospheric field, Congress has mandated NOAA to report on weather modification and is designing a major new climate program.

"The new organizational structure recognizes these new duties and addresses a growing concern for this country to have a national ocean policy which reflects the emerging importance of the oceans," Secretary Kreps said. "President Carter has informed Congress of his intention that a coherent national ocean policy be developed and implemented, and this will permit the Commerce Department to carry out his wishes."

The new structure reduces the number of key line officers from nine career managers to four policy-level Assistant Administrators for Fisheries, Coastal Zone Management, Research and Development, and Oceanic and Atmospheric Services.

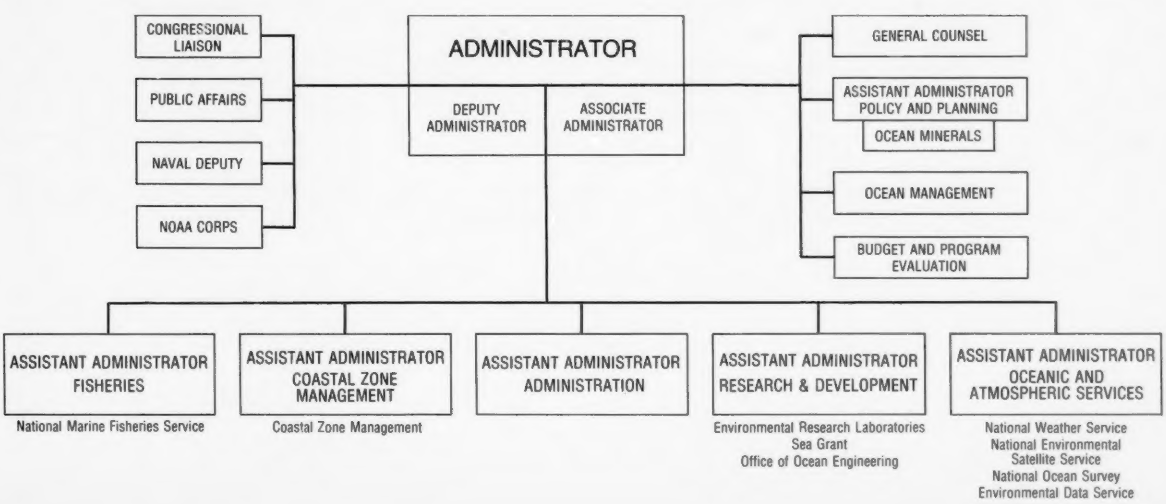
The Assistant Administrator for Fisheries is responsible for fisheries policy and the National Marine Fisheries Service. The NOAA fisheries program develops fisheries management plans in the 200-mile coastal fisheries zone, assists the fishing industry and protects marine mammals.

The Assistant Administrator for Coastal Zone Management is responsible for the coastal zone and Coastal Energy Impact Fund Programs. The coastal zone management program works with state and local governments to assure a balanced approach to the development and conservation of critical coastal areas.

The Assistant Administrator for Research and Development is responsible for the NOAA Environmental Research Laboratories, the National Sea Grant Program, the Office of Ocean Engineering, and coordination of NOAA research activities with the rest of the Federal Government and the scientific community.

The Assistant Administrator for Oceanic and Atmospheric Services is responsible for the National Weather Service, the National Environmental Satellite Service, the National Ocean Survey, and the Environmental Data Service.

The existing staff offices of Associate Administrator for Marine Resources and Associate Administrator



for Environmental Monitoring and Prediction are abolished. Their responsibilities go in part to the Assistant Administrators mentioned above. Their policy development functions are transferred to a new Assistant Administrator for Policy and Planning.

Special attention will be given to four areas of growing concern: Ocean Management, National Climate Policy, Marine Mammals, and Ocean Minerals.

An Office of Ocean Management, reporting to the Administrator, will be created to develop plans for the wise and productive use of ocean areas and to evaluate proposals by others for ocean projects. The office will engage in the marine analogue to land use planning.

A new Office of National Climate Policy will be created, reporting to the Assistant Administrator for Research and Development. It will provide leadership and focus for the developing national concern over such issues as drought, weather modification, and the ocean-atmosphere weather interface.

The Office of Marine Mammals will be upgraded to report directly to the Assistant Administrator for Fisheries, in light of the increasingly significant impact of marine mammal and endangered species protection regulations.

An Office of Ocean Minerals, reporting to the Assistant Administrator for Policy and Planning, will be established to work with Congress, the Executive Branch, industry, and environmental and other concerned organizations in moving forward with and managing a national program for deep ocean mineral resources development.

The plan was formulated after extensive consultation with members of Congress, other parts of the Executive Branch, NOAA personnel, and constituency groups, including the scientific community.

NOAA Ship Gets Cuban Diplomatic Clearance

An oceanographic research vessel operated by the National Oceanic and Atmospheric Administration (NOAA) became the first U.S. ship to receive diplomatic clearance to operate in Cuban waters in the past 16 years, the Commerce Department agency has announced. In July the 278-foot, 2,800-ton *Researcher*, sailing as part of a study of the Gulf of Mexico Loop Current, was inside Cuban territorial waters for about a day and a half, measuring water salinity, water temperature, and depth.

NOAA officials, working through the State Department, obtained permission for the *Researcher* to make the measurements at a site 2.9 miles from the Cuban mainland, off Havana. Cuba claims jurisdiction over waters 200 miles from its coastline, but the United States only recognizes the traditional 3-mile jurisdiction.

The *Researcher* sailed into Cuban waters the evening of 13 July, after picking up two Cuban scientific observers at a rendezvous point. The measurements were made during the next 24 hours, and the observers were disembarked the morning of 15 July. There were no incidents, NOAA officials said, and the scientists from both countries worked in "professional harmony." Results of the tests were provided the Cuban observers.

The *Researcher* carries a complement of 76 officers, scientists, and crew. Its 4,000-square foot laboratory is equipped with the latest oceanographic research equipment.

COUNCIL TO PROMOTE FISH VESSEL SAFETY

The Department of Commerce's National Marine Fisheries Service and the U.S. fishing industry are forming a National Council on Fishing Vessel Insurance and Safety.

Expected to affect the approximately 150,000 U.S. fishermen and the owners of 90,000 fishing craft operating in all coastal seafood production states, the Council will promote safety standards in fishing vessel construction, maintenance, and operation. It will conduct training programs and an information system on safety, provide technical assistance, act as emissary in dealing with government agencies, and seek funding from private and government sources.

The broad span of Council activities will relate to Federal programs of the Departments of Commerce, Transportation, Labor, and Health, Education and Welfare, as well as with the insurance and general maritime industries. The National Council will carry on the work of an ad hoc group formed in 1973, and will be established as a nonprofit organization of industry members.

Fish Retail Price Index Increases 1.7% in July

The retail price index (seasonally unadjusted) for fish rose again in July by 1.7 percent over June and by 14.8 percent above July 1976, according to a monthly statistical analysis by the National Marine Fisheries Service. Of the 17 frozen and canned fishery products surveyed in July by the Commerce Department Agency, an element of the National Oceanic and Atmospheric Administration, 13 increased, 1 declined, and 3 were unchanged.

Prices increased for cod, haddock, ocean perch, and turbot fillets; halibut steak; king crab meat; fish sticks; breaded shrimp; canned solid white and chunk light tuna; canned pink salmon; and canned Maine and Norway sardines. On the other hand, prices decreased for fish portions. Unchanged were flounder and whiting fillets, and canned red salmon.

Retail prices of poultry increased more from the previous month during

July than for meat and fish. Retail poultry prices in July rose 3.9 percent from June. Meat prices rose 1.2 percent in July from June on the strength of higher prices for round and chuck steaks, loin pork chops, and roasts. When compared with a year earlier levels, prices for meat were 3.5 percent higher, but prices had declined 1.3 percent.

Ten cities are surveyed every month by officials of NMFS, who report prices of selected items of fish, meat, and poultry items for "Operation Fish Watch." They visit three different chain stores in each city and check the prices for the same representative brand names and types of products to determine any changes from the previous month.

The cities surveyed are: Atlanta, Ga.; Boston, Mass.; Little Rock, Ark.; Galveston, Tex.; San Francisco and Los Angeles, Calif.; Pascagoula, Miss.; St. Petersburg, Fla.; Seattle, Wash.; and Washington, D.C.

Shellfish Prices Seen Stabilizing

Prices for most shellfish products have increased to record levels over the past 2 years, but further significant increases are unlikely, according to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, a Commerce Department agency. Strong demand for shellfish products experienced in the first quarter of 1977 should continue in the coming months and will keep prices high, although seasonal declines can be expected, officials said.

Shrimp, scallops, and lobster tails are expected to be plentiful in the coming months. Greater supplies of shrimp and scallops will come from high domestic production and from seasonally heavy imports. Imports of warm-water lobster tails should be increasing, but imports of cold-water lobster tails will be seasonally low.

Until next year, snow crab production will be limited because effort will be shifting to the king crab fishery where production is expected to rise from 10 to 15 percent over last year.

Supplies of clams are still down appreciably from previous years because of the depletion of the surf clam resource. This has caused effort to shift to the quahog fishery, but the gains achieved in that fishery have not as yet reversed the overall decline in clam production.

Blue crab and oyster production for the rest of the year will likely reflect the high mortalities that resulted from the cold winter. Production from the Chesapeake Bay will be more heavily influenced than production from other areas.

Copies of "Shellfish—Market Review and Outlook—June 1977" are available by writing to the Industry and Consumer Services Division, National Marine Fisheries Service, NOAA, Washington, DC 20235.

Foreign Fishery Vessels Off U.S. Coasts Increase

The number of foreign fishing and fishing support vessels sighted off U.S. coasts in July increased slightly over the number sighted in June, according to preliminary figures released by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, a Commerce Department agency. In July, 786 vessels were sighted as compared with 767 sighted in June, reflecting the normal fishing patterns for this time of year. During July 1976, 842 vessels were reported off our coasts.

The foreign vessels, from eight nations, were sighted off the coasts of New England and the mid-Atlantic States, Gulf of Mexico, west coast, and Alaska. The largest number was from Japan, which had 634 vessels fishing for salmon and pollock off Alaska, 11 fishing for squid off New England and mid-Atlantic, and 2 longline vessels fishing for tuna in the Gulf of Mexico. The Soviet Union had 73 vessels: 39 fishing for hake off the Pacific coast, 27 fishing for squid off New England and mid-Atlantic, and 7 catching pollock in Alaskan waters.

Canada, fishing under a reciprocal agreement with the United States, had 19 vessels: 8 fishing for salmon and 5 fishing for halibut off Alaska, and 6 fishing for salmon off the west coast. Spain had 27 vessels fishing for squid off New England and mid-Atlantic. South Korea had 11 vessels fishing for sablefish off Alaska. Poland had 6 vessels fishing for hake off the west coast. Italy had 2 vessels fishing for squid off New England and mid-Atlantic. France had one vessel supporting the Polish hake fishery off the Pacific coast.

A summary of Foreign fishing vessels operating off U.S. coasts during July 1977 and July 1976 follows:

		No. of vessels	
Area	Nations	July 1977	July 1976
New England and mid-Atlantic	Soviet Union	27	0
	Poland	0	3
	W. Germany	0	3
	Spain	27	2
	Japan	11	5
	Italy	2	6
	S. Korea	0	2
	Total	67	21
Gulf of Mexico	Japan	2	7
	Cuba	0	31
	Total	2	38
West coast	Japan	0	2
	Soviet Union	39	77
	S. Korea	0	18
	Bulgaria	0	3
	Poland	6	6
	E. Germany	0	4
	Canada	6	0[1]
	France	1	0
	Total	52	110
Alaska	Canada	13	0[1]
	Japan	634	517
	S. Korea	11	57
	Taiwan	0	3
	Soviet Union	7	96
	Total	665	673
	Grand total	786	842

[1]Number of Canadian vessels off U.S. shores not recorded.

The July sightings were made by representatives of the National Marine Fisheries Service and by personnel of the U.S. Coast Guard, conducting joint fisheries enforcement patrols from Coast Guard aircraft and cutters.

Foreign vessels sighted off the coasts in 1976 were as follows: January 420; February, 510; March, 435; April, 560; May, 924; June, 970; July, 842; August, 543; September, 514; October, 452; November, 258; and December, 240. In 1977: January, 319; February, 314; March, 180; April, 235; May, 374; June, 767; and July, 786.

Fishery Management Council Members Named

Richard A. Frank, Administrator of the National Oceanic and Atmospheric Administration, acting in behalf of the Secretary of Commerce, has appointed 7 new members and 13 incumbents to vacancies on the nation's eight Regional Fishery Management Councils. Nineteen of the appointments are for 3 years, filling expired 1-year terms, and the remaining appointment is to complete the unexpired term of a member who resigned. All appointments were effective 11 August 1977.

The Councils, established by the Fishery Conservation and Management Act of 1976, are responsible for preparing fishery management plans for stocks of fish found in waters within their geographical areas. The Act requires that members to the Councils be selected from lists of qualified individuals submitted by the Governors of the States involved. Forty-eight Council members were appointed in August 1976 for 2- or 3-year terms.

New members appointed were: Herbert R. Drake, General Manager, H. R. Drake & Sons, Rye Harbor, N.H.; Omar G. Allvard, Electric Boat Division, General Dynamics Corp., Groton, Conn.; and Robert Lowry, retired State conservation officer, Carolina, R.I., all to the New England Council; Barbara B. Porter, President, South Shore Marina, Inc., Bethany Beach, Del., and Harry M. Keene, Easton, Md., charter boat owner-operator, both to the Mid-Atlantic Council; and Margaret (Peggy) Stamey, Raleigh, N.C., to the South Atlantic Council; and Gordon Jensen, commercial fisherman, Petersburg, Alaska, to the North Pacific Council.

Incumbents reappointed were: Thomas A. Norris, Milton, Mass., Vice-President, McCormack and Old Colony Trawling Corporations (New England Council); David H. Hart, marine fisheries consultant, Cape May, N.J., and William J. Hargis, Jr., Director, Virginia Institute of Marine Science, Gloucester Point, Va. (Mid-Atlantic Council); and Edgar C. Glenn, Jr., retired, Beaufort, S.C. (South Atlantic Council).

Reappointed to the Gulf of Mexico Council were John M. Green, President, Miller-Vidor Land and E. H. Green Lumber Companies, Beaumont, Tex.; George A. Brumfield, Manager, Mississippi Operations, Zapata-Haynie Corp., Moss Point, Miss.; and Billy J. Putnam, charter boat captain, Panama City Beach, Fla.

Other reappointments include John A. Harms, Jr., President, Lagoon Marina, Inc., Red Hook, St. Thomas, Virgin Islands (Caribbean Council); Peter S. Fithian, Director, Greeters of Hawaii, Ltd., Honolulu, and Louis K. Agard, Jr., commercial fish spotter, Honolulu (Western Pacific Council); Herman J. McDevitt, attorney, Pocatello, Idaho, and Vernon J. Smith, supervising electrician, Santa Clara County, San Jose, Calif. (Pacific Council); and Clem Tillion, fishing boat charters, Halibut Cove, Alaska (North Pacific Council).

In addition to the appointed members, the Act establishes as voting members the principal State official with marine fishery management responsibility and expertise in each constituent State, as designated by the respective Governors, and the Regional Director of the National Marine Fisheries Service, NOAA, for the area.

Additional fisheries expertise is provided to the Councils through nonvoting members consisting of the Regional or Area Director for the U.S. Fish and Wildlife Service or his designee; the Commander of the Coast Guard District or his designee; the Executive Director of the Marine Fisheries Commission, if any, or his designee, for the geographical areas of the Councils; and a representative from the State Department.

Fishery Research Vessels Modified

The National Oceanic and Atmospheric Administration has announced that a $230,000 contract has been awarded to M. Rosenblatt and Son, 350 Broadway, New York, N.Y., for naval architectural and engineering services. The Commerce Department agency said the firm, under the 12-month contract, will consult with NOAA's National Ocean Survey on the upgrading of four fisheries research ships which require extensive shipyard modifications. Other technical support will be provided for the design of a new shallow-draft hydrographic survey launch and the installation of pollution control systems on all of these vessels.

The NOAA fleet is made up of 28 vessels, ranging in size from 65 to 303 feet, whose homeports are in Norfolk, Va., Seattle, Wash., and Miami, Fla.

Porpoise Quota Raised

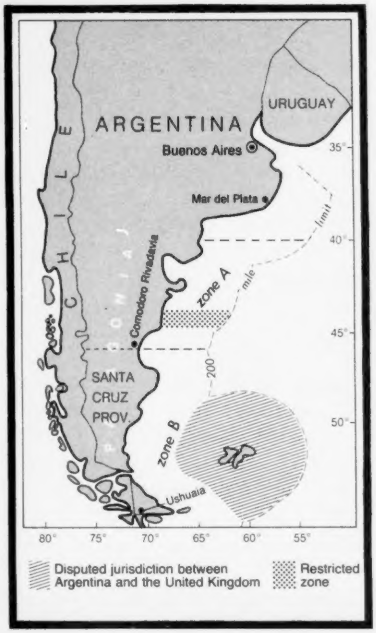
The number of whitebelly spinner porpoise that may be killed during U.S. yellowfin tuna purse seine fishing operations in 1977 has been increased from 7,840 to 11,219, according to the National Oceanic and Atmospheric Administration (NOAA), a Department of Commerce agency.

The original quota established by NOAA's National Marine Fisheries Service was based on a population estimated at 549,000 whitebelly spinners; however, recent scientific information sets the stock population at 690,000 animals. The increase in the whitebelly quota raised the total 1977 quota for all species that may be killed to 62,429. Through 24 July, 9,864 porpoises of all stocks had been killed in the fishery; of these 2,079 were whitebelly spinners. A total of 30,400 whitebelly spinners was killed in 1976.

Germany, Japan Will Fish Argentine Waters

Foreign interest is growing in the untapped stocks of hake and other fish off the coast of southern Argentina, the NMFS Office of International Fisheries reports. In June 1977, the Argentine Government awarded 1-year contracts to consortia from Japan and the Federal Republic of Germany to catch up to a total of 200,000 metric tons (t) of fish in Argentine waters. Part of the contract involves stock assessment aimed at determining the region's fishery resources.

Substantial fishery resources are reported off Argentina's southern coast, but its domestic fishing industry utilizes these stocks only to a limited extent. Argentina decided to allow foreign fishermen access to its 200-mile Territorial Sea as part of a national effort to increase domestic fish and shellfish consumption and to earn foreign exchange by increasing exports. Both Japan and the FRG are sending fishery research vessels to Argentine waters to assess fishery resources.



EXTENDED JURISDICTION

Argentina declared a 200-mile Territorial Sea in 1967 in response to the Soviet fishing for hake which reached record levels in that year. The Soviet 1967 catch of 680,000 t off Argentina was reduced to negligible amounts in 1968 when the Argentine Navy fired on and seized two Soviet trawlers fishing within 200 miles of the Argentine coast. Brazilian sardine fishermen who had operated off northern Argentina were also forced to withdraw from Argentine-claimed waters.

RESOURCES

Scientific estimates of the fisheries biomass off Argentina prepared by the Subsecretariat of Fisheries of the Ministry of the Economy range up to 10 million t. An annual maximum sustainable yield (MSY) of 2 million t is believed possible. Currently, less than 300,000 t of fish are caught by Argentine fishermen, most of it by the fishermen from the northern port of Mar del Plata. The area below lat. 46° (see map) is still virtually untapped and little is known about the extent of the living resources there. The major species found off Argentina include Patagonian hake, anchovy, pollock, and krill.

Research conducted by the Japanese Fishery Resource Research Center from November 1976 to January 1977 suggests that a groundfish fishery may not be possible south of lat. 46°S, and hake was found to be far less abundant than in the north. The Japanese pointed out that it was still necessary to conduct exploratory fishing during the winter season (July and August) before drawing any final conclusions on the resources of the area.

DOMESTIC FISHING INDUSTRY

Argentina's fishing industry has traditionally been a neglected sector of the economy. The fishing fleet is small and antiquated. Port facilities in the north are inadequate and almost nonexistent in the south. The canning industry is not competitive with foreign canners due to the high price of tin and steel and the poor quality of canning oils available in Argentina.

Domestic consumption of fish is low (2.5 kg per capita in 1970) because beef and mutton are inexpensive. Domestic fish consumption is not expected to increase substantially as long as the Government maintains low meat prices. There is some indication, however, that the new government of General Videla may allow the prices of meat and other food commodities to raise to world market levels. There are extensive freezing facilities for beef in Argentina, but only a few freeze fishery products, especially along the Patagonian coast.

ARGENTINE POLICY

With its large and untapped fishery resources, Argentina is an attractive target for the foreign distant-water fleets which have been forced out of their traditional Northern Hemisphere fishing grounds by the proliferation of 200-mile fishing zones. The Argentine Government now seems to have softened its earlier opposition to foreign fishing and is interested in considering the possibility of joint fishery ventures with foreign companies.

The governments of Presidents Alejandro Lanusse and Juan Peron began to review fisheries development in the early 1970's and attempted to encourage foreign participation. A British trawler fished for 6 months off Argentina in 1972. During the last administration of Juan Peron (1973-74), an effort was made to broaden Argentina's trad-

ing partners and various letters of intent were signed with Socialist Bloc countries, primarily the USSR and Poland, for cooperation in developing fishing port facilities.

FOREIGN INTEREST IN ARGENTINA

Poland was especially interested in establishing a joint fishery venture with Argentina and signed a letter of intent to that effect in May 1974. Poland proposed chartering Polish-flag vessels and motherships and marketing the catch through a Polish trading company. In return, Poland was to construct a new port facility in the southern province of Santa Cruz. The proposal was criticized for infringing on Argentine sovereignty, competing with the domestic fishing fleet, and being economically unsound. No joint venture was established as a result.

Santo Domingo, a Spanish fishing company, signed a merger agreement with the Argentine firm Antartida Pesquera Industrial in early 1977. The new company is to carry out joint fishing off southern Argentina. Cold storage and processing facilities will be built in Ushuaia, 3,100 km south of Buenos Aires. Most of the catch will be exported to Europe. It is expected that up to 40,000 t will be exported to Spain annually.

The Spaniards will provide the technology, vessels, crews, and will also handle sales. A total of $30 million is being invested in this joint company by the Argentine Development Bank, private Argentine investors, and a group of Belgian financiers. It is not known what species will be caught and processed or if the company has access to data which contradicts preliminary Japanese findings that hake stocks south of lat. 46°S will not support a commercial fishery.

Japan has also placed considerable importance on gaining access to Argentina's fishery resources. The hake and pollock stocks off Argentina offer attractive substitutes for the declining allocations of these species from the United States and USSR 200-mile fishery zones. As a result, the Japanese have sent various missions of government and industry officials to negotiate joint ventures in Argentina.

JAPAN AND THE FRG AUTHORIZED TO FISH

The Argentine Government decreed in January 1977 a 200,000 t quota for foreign fishermen within 200 miles of its coast. Hake was to compose 75 percent of this total. Argentina stands to gain not only increased export revenue and foreign exchange, but also hopes to procure long-term, low-interest loans from the countries allowed to fish in its waters. Argentina requires that 10 percent of the quota be landed and marketed domestically. Argentine fishermen criticized the government for allowing foreign fishing despite the fact that the domestic fleet catches only 15 percent of the potential MSY.

In February 1977, Argentina invited companies from foreign countries to submit bids to fish off Argentina. The government planned to choose two foreign bidders for the 1-year term and split the 200,000 t quota equally. Besides the stipulations outlined in the January decree, the contract recipients would also have to provide research vessels for stock assessment immediately and provide loans for Argentina to build its own research fleet. Argentina does not plan to collect license fees because its emphasis is on fishery development rather than on raising revenue.

Firms and agencies in seven countries submitted bids: Cunard (United Kingdom); Polish Fishing Industry Board (Poland); Compania Argentino-Portuguesa (Portugal); the Government of Bulgaria; Pittsburgh S.A. representing Thyssen Rheinstahl GmbH (FRG); Korea Wonyang Fisheries Co., Ltd. (ROK); and two consortia.

The first consortium was composed of FRG companies (Hanseatische

Norway Investigates Fish Protein Losses

Of the total amount of protein available in Norway in 1974, 600,000 tons were produced domestically, while about 170,000 tons were imported. About 64 percent of the Norwegian-produced protein came from the fishing industry and 26 percent came from agriculture. Imports consisted of 75 percent feed concentrate, 20 percent food grain, and the remainder in imported fish and agricultural products.

Out of the total protein available in Norway, over 270,000 tons, or about a third, was exported and of this over 98 percent was in the form of fish products. Within Norway twice as much protein was used as animal fodder as was used for food for human consumption—or in other words 230,000 tons. Imported and Norwegian-produced feed concentrate supplied 94 percent of all animal fodder, while the rest came from potatoes and fish products.

The protein residue from production processing industries has been calculated to be about 111,000 tons and of this about half is recoverable and is used in the feeding of animals. Out of the 55,000 tons lost in processing, about 80 percent or 42,000 tons was lost in the fish processing industry. As a result of this, the Fisheries Ministry set up a by-product committee to consider the question of the recoverability of residue from the fishing industry and to report the exact protein losses. The figures on general protein quantities and their loss come from a report prepared under the auspices of the Norwegian Council for Scientific and Industrial Research (NTNF).

Hochseefischerie, Hochseefischerei Nordester, Nordsee Deutsche Hochseefischerei, and F.M.S. Scombrus Fischfang) and the second included Japanese companies (Nippon Suisan, Taiyo, Kyokuyo, Hoko Suisan, and Nichiro).

The Argentine Ministry of the Economy announced on 16 June 1977 that both the Japanese and FRG consortia had been awarded 1-year contracts. Their area of operation within the Argentine 200-mile zone is between lat. 40° and 46°S (Zone A on map). During the hake spawning season (1 October to 31 January), the foreign firms will be restricted from fishing in the area bounded by the coast in the west, long. 63°W in the east, lat. 43°30′S in the north and lat. 44°30′S in the south (restricted zone on map).

The Japanese journal *Suisan Tsushin* has reported that the provision to supply a research vessel will be met by sending the RV *Shinkai Maru* during the 1977-78 fishing season. Argentine regulations require that the vessel fly the Argentine flag, and a registry transfer must be approved by the Japanese Government. Another Argentine requirement for Japan to provide long-term, low-interest loans for the construction of an Argentine research vessel will be met by Japanese Government agencies (70 percent) and the Japanese consortium (30 percent). The vessel will cost between an estimated $10.6 and $14.2 million.

The Japanese also will be required to carry out feasibility studies for port construction in southern Argentina. Two trawlers, the *Hinan Maru* owned by Nippon Suisan and another from either Taiyo or Nichiro, will be fishing off Argentina. Press reports indicate that Argentina has agreed to allow Japanese fishermen to immigrate to Argentina.

The FRG will be required to provide essentially the same credit arrangements for the construction of an Argentine research vessel, as well as financing a feasibility study of a new port and a fish processing facility in southern Argentina. It is reported that two of the West German vessels which will participate in the stock assessment are the RV *Walther Herwig* and the RV *Anton Dohrn*.

The two foreign consortia will be allowed to continue fishing in Argentine waters and establish joint-venture companies provided the 1-year trial period is satisfactory to both parties. German press reports indicate the FRG consortium will be allowed to form a joint-venture with 51 percent German ownership. It is not known if the same terms will be extended to the Japanese consortium. If the results of the stock assessment research indicate a large MSY (maximum sustainable yield) and the 1-year experiment is successful, foreign quotas may be increased and other countries besides Japan and West Germany may be allowed to participate in the fishery of that region.

POSSIBLE KOREAN PARTICIPATION

The Argentine agreement with Japan and the FRG will help develop the fisheries between lat. 40° and 46°S, but fishery resources in the region further south will still remain largely unutilized. It appears that the Argentine Government will open this area to foreign participation under conditions similar to the ones imposed on Japan and the FRG.

Press reports from the ROK (Republic of Korea) indicate that Argentina has agreed, in principle, to allow Korean vessels to take 100,000 t annually south of lat. 46°S (Zone B). It is also reported that up to 2,000 Korean fishermen would be allowed to immigrate to Argentina. The discussions between Argentine and Korean fishery officials that led to the reported agreement will be followed by more formal negotiations and research to assess fish stocks off southern Argentina.

According to the NMFS Office of International Fisheries, the Argentine action may influence the way other coastal nations, particularly those in the developing world, will regulate foreign fisheries. The agreements indicate that significant concessions from the foreign companies can be obtained by a coastal nation in return for allowing eager foreign fishermen access to fishery resources there. Many distant water fishing countries have large fishing fleets which are idle because of the closure of their traditional fishing grounds by the extended jurisdictions of coastal countries. The agreements signed with Argentina indicate the price that these distant water fishing countries are willing to pay for access to fishing grounds.

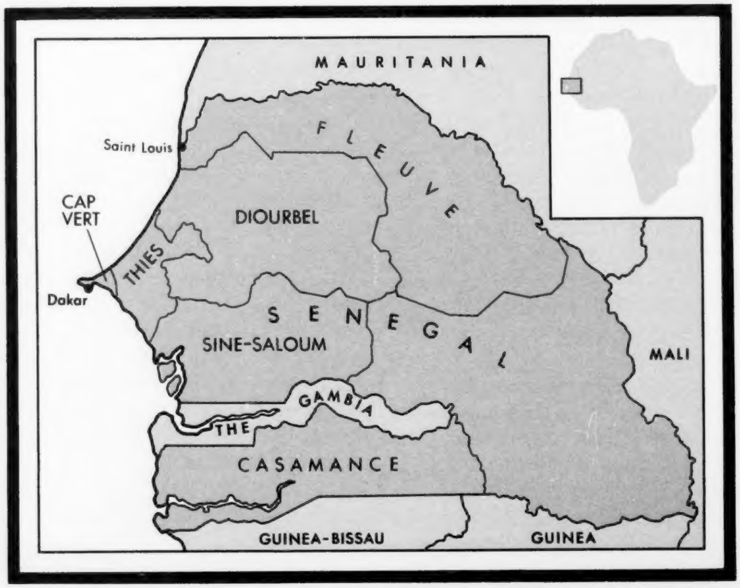
Norway Aids Fishermen With Damaged Gear

The Norwegian Ministry of Fisheries has paid 7.85 million kroner in compensation to fishermen whose equipment was damaged as a result of oil offshore work in the North Sea. There were 1,380 applications for compensation, 995 of which have been approved. The average payout has been 7,890 kroner. Out of the total applications turned down, 140 were refused on the grounds that they had been sent in too late, and these delayed applications represent a total sum of over 1.1 million kroner.

Most of the applications considered were for the period 1975-76; only a few applied to 1974 and a handful to 1973. Some from 1977 have also been processed. Most damage applied to trawlers or to mackerel nets. While scrap on the seabed was the main cause for damage to trawlers, supply ships were the main source of damage to mackerel nets. A total of 12 million kroner had been allocated for such compensation: 8 million until the end of 1976 and 4 million for 1977 by late summer.

The Lobster Fishery of Senegal

Senegalese fishermen caught 262 metric tons (t) of spiny lobster in 1976, a decrease of 46 percent over the record 1975 catch of 483 t. A total of 74 t were exported in 1975, most of which was shipped live to France.



SPECIES AND GROUNDS

The spiny lobster caught by Senegalese fishermen include pink lobster, *Palinurus mauritanicus*, and green lobster, *Panulirus regius*. Lobster is found in various locations along the coast of Senegal and was particularly abundant in 1975 off the coast of the Sine-Saloum region between Dakar and The Gambia (see map). In 1974, the best catches were made off Dakar in the region of Cap Vert, and near Saint Louis in the Fleuve Region of northern Senegal.

METHODS

Artisanal fishermen using dugout canoes, or pirogues[1], landed over 87 percent of the 1975 lobster catch of 483 t. The remaining 62 t (13 percent of the catch) was landed as the incidental catch of the commercial trawlers which fish primarily for sole, shrimp, capitaine, and dentex, and by a few specialized lobster vessels.

CATCH

Senegal's lobster catches increased fourfold from the 1965 and 1966 catches of 90 t, to the 1975 catch of nearly 500 t. This increase is primarily due to the enlargement of the fleet and to an intensive program begun in the early 1970's to finance the purchase of outboard motors by the canoe fishermen.

An agreement concluded with Canada in 1972 provided for the purchase of 3,500 outboard motors as well as for the construction of storage, distribution, and maintenance facilities for the motors. As a result, the fishermen were able to significantly increase their catches in 1974 and 1975 (Fig. 1). The 1976 lobster catch, however, decreased by nearly 50 percent (Table 1), according to Senegalese statistics. This decline was partly attributed to high winds, especially in the Cap Vert region, and to mechanical problems with the last shipment of outboard motors.

Catches in each region vary considerably from year to year, and available regional catch data do not show a pattern of continually higher catches in any particular region. In 1974 the largest catches were made in the Fleuve region bordering Mauritania in the north, although in 1975 the best catches were in the Sine-Saloum region. The largest

[1]Over 67 percent of the pirogues are now equipped with 10-25 horsepower outboard motors.

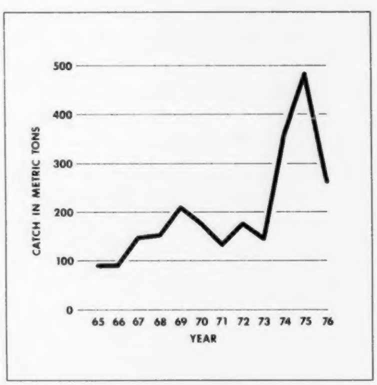


Figure 1.—Senegal's annual lobster catch, 1965-75, in metric tons. Source: Fishery Committee for the Eastern Central Atlantic, "Statistical Bulletin No. 1, Nominal Catches 1964-74."

Table 1.—Senegal's artisanal and commercial lobster landings by region, 1974-75, in metric tons.

Fishery and region	1976	1975	1974
Artisanal			
Fleuve	38	36	123
Diourbel[1]	—	—	—
Thies	135	88	48
Cap Vert	28	6	110
Sine-Saloum	NA	276	NA
Casamance	13	15	17
Total	214	421	298
Commercial[2]	48	62	60
Grand Total	262	483	358

Table 2.—Senegal's incidental lobster trawl catches, by month, 1975-76, in metric tons, and vessels employed.

Month	Catch[1] 1976	Catch[1] 1975	Vessels 1976	Vessels 1975
January	4.54	6.39	60	71
February	5.13	7.70	67	82
March	5.87	8.71	66	74
April	9.95	6.51	65	74
May	6.34	8.11	66	70
June	5.30	6.91	67	69
July	1.74	3.75	65	78
August	1.30	1.72	66	67
September	0.78	1.74	67	61
October	0.31	0.71	63	56
November	0.22	7.89	67	58
December	6.95	2.07	68	61
Total[2]	48.43	62.21		

[1]Assumed to be whole weight landings.
[2]Totals may not agree due to rounding.
Source: Direction de l'Océanographie et des Pêches Maritimes, Ministère du Développement Rural et de l'Hydraulique, Senegal.

amounts of lobster caught in 1976 were taken in the Thies region, due to the large number of fishermen there and the consequent intense fishing effort (Table 1). No catches of any type of fish or crustaceans were reported for the Diourbel region.

Data for the commercial fishery show that catches are highest during the dry season from November to June (Table 2), but monthly catch data for the artisanal fishery are not available. Catches decline during the rainy season which lasts from July through October.

PROCESSING

Live Lobster

Senegal is the only West African country which currently exports a large amount of live lobster, according to a report prepared for the International Civil Aviation Organization (ICAO)[2]. The report notes that this is due to a general lack of experience and organization needed to take advantage of the resources that exist in West African waters. In addition, lobster which is caught by trawl is often bruised or damaged, making it unsuitable for live export. Senegal has several specialized lobster vessels capable of delivering undamaged lobsters for live export.

Lobsters to be shipped live are offloaded and held in tanks for at least 24 hours to permit cleansing and to allow the lobsters to recover from the shock of being caught and handled. This also permits the exporter to accumulate enough lobster for a full shipment. The tanks do not have provision for water circulation, and no control is exercised over temperature, oxygen content, or water quality in general. When the exporter has enough lobster, they are packed in corrugated cardboard cartons with wet seaweed or wood shavings. The cartons are loaded full and the packer compresses the lobsters slightly when securing the lid. This restricts movement and minimizes damage to the lobsters during transit.

Research has shown that the storage life of live lobsters depends on the temperature at which they are kept. Lobster to be shipped live should be held for at least 24 hours and the water temperature gradually reduced to about 6°C to slow the lobsters' metabolism and activity, which reduces mortality in transit[3]. The ICAO study (Footnote 2) recommends that shipping containers be insulated to prevent sudden temperature changes. The study concludes that:

"Although the existing quality of crawfish (lobster) as delivered to the European import markets is acceptable, improvements can and should be made since the present practices and standards of hygiene are generally poor in comparison to those employed by companies in major crawfish exporting countries . . . handling, processing, and distribution procedures must be upgraded if the West African trade is to compete in world markets."

Table 3.—Senegal's lobster production for export, by company and commodity, 1974-76, in metric tons.

Country	Year 1976	1975	1974
G.V.D.	44.7	53.2	46.6
Sosechal	22.0	16.8	18.6
Sopesea	1.0	1.9	0.4
SPAC	—	0.7	20.5
Other[1]	11.3	1.7	2.8
Total	78.0	74.3	88.9

[1]Includes Surgel, Senepesca, Adripêche, Safcop, Sopao, Issa Konte, Procos, and Afrique-Langouste.
Source: Senegal. Direction de l'Océanographie et des Pêches Maritimes. Ministère du Développement Rural et de l'Hydraulique.

Frozen Tails

Lobsters to be used for the production of frozen tails are usually de-tailed on board and the tails are packed on ice. When they reach the shore-based processing plant, the tails are washed and cleaned by hand. After freezing, the tails are individually packed in plastic bags and placed in cartons (usually 10 kg) for quick freezing and shipment.

COMPANIES

Nine Senegalese companies, most of which process several other species, processed lobster in 1975 for export. By far the largest of the companies is Les Grandes Viviers de Dakar (G.V.D.), a company which specializes in exporting live lobster. Its 1976 production was 44 t or 57 percent of the total Senegalese lobster exports (Table 3). The second largest amount of lobster was produced by Sosechal, which has plants in Dakar and at Ziguinchor in the Casamance region. Primarily a shrimp exporting company, Sosechal produced 22 t of lobster in 1976 (28 percent of the total). SPAC (Société Sénégalaise de Produits Alimentaires Congelés) of Dakar, a company which also processes perch, shrimp, and sole, produced 20 t of cooked lobster in 1974. Its 1975 lobster production fell to less than 1 t, and in 1976 SPAC stopped producing lobster. Small quantities of live and cooked lobster and frozen tails are produced by several other companies (Table 3).

EXPORTS

Senegal, unlike many developing countries, consumes most of its lobster catch domestically. Exports accounted for only 15 percent of the 483 t caught in 1975. Most Senegalese are Moslem and therefore do not eat shellfish for religious reasons. However, the 500,000 foreigners who live in Senegal and the relatively large tourist industry may account for the large domestic lobster consumption.

Senegal exported 74.3 t of spiny lobster in 1975, an 18 percent decline from the 90.5 t marketed abroad in 1974. Live lobster made up over 67 percent of all export shipments in 1974.

Most of Senegal's lobster is marketed in France. Export statistics by commodity are not yet available for 1975 and 1976, but French import statistics indicate that France imported 62 t of live lobster from Senegal in 1975. In 1975, about 70 t of lobster—94 percent of all spiny lobster exports—were shipped to France, mostly by air freight. In 1974, 54.8 t of lobster were shipped to France.

Spain imported 2.9 t of lobster from Senegal in 1975 and 12.4 t in 1974 while Italy imported 22.3 t from Senegal in 1974. Other nations imported 0.9 t of lobster from Senegal in 1974 and 1.4 t in 1975. The United States does not import any lobster from Senegal.

[2]"A Review of the Trade in Fish Transported by Air from Selected African Countries," International Civil Aviation Organization, October 1976 (UNDP/ICAO Project RAF/74/021).

[3]Lobsters will live for 10 days at 0°C but only for 3½ days at 10°C. A storage temperature of 5°C has proven most desirable.

Mauritius-USSR Fishing Pact Not Renewed

The Mauritian Government has decided not to renew the fishing agreement with the Soviet Union which was signed in 1970 and expired in 1976. This agreement, renewed twice in the past, provided the Soviets with certain port facilities in return for Soviet assistance to the Mauritian fishing industry.

The decision of the Mauritian Government, made in May 1977, was motivated partly by the lack of reciprocity on the part of the Soviets, and also by certain Soviet activities that the Government considered to be prejudicial to Mauritian interests.

THE SOVIET AGREEMENT

In the 1970 agreement, the Soviets promised to deliver fish, organize fishing cooperatives, donate fishing equipment such as outboard motors and nets, assist in vessel construction and technological development, etc. The Mauritian Government believes that this agreement was not respected and it is said that, apart from some gifts of fish and a few nets and some other minor donations, the Soviets showed little interest in carrying out the terms of the agreement. As for the Soviet mission sent to study the Mauritian fishing industry and the opportunities for fisheries cooperation, it was said in official Mauritian circles that the Soviet aid proposals were unacceptable because of the "strings" attached to them, which would have been in conflict with national interests.

The Prime Minister, Seewoosagur Ramgoolan, decided against the renewal of the agreement for which the USSR had been exerting a great deal of pressure. Officials close to the Prime Minister said that he was "very disappointed" in the activities of certain Soviet nationals in Mauritius, the use and channeling of money obtained by the Soviet Embassy for its cultural funds, and the release of Mauritian money to Soviet vessels which anchored in Port Louis. It was alleged that on several occasions in 1976 the Soviets spent as much as Rs. 80,000[1] per vessel for provisions as opposed to Rs. 20,000-30,000 in previous months. Since it was impossible to keep track of the use of Mauritian currency, the Finance Minister decided to restrict the sums released for Soviet crews.

JAPAN MAY SIGN

According to *L'Express*, it is possible that the Mauritian Government will sign a fishing agreement with Japan similar to the one it had with the Soviet Union. This agreement would permit the Japanese-owned KGKK[2] company to proceed with an expansion of its current activities and would permit the use of port facilities and the regulated exploitation of fishery resources in the new Mauritian 200-mile zone. The KGKK forms part of the Mitsubishi group and has been using a fishing base at Trou Fanfaron for 15 years. After the contract between the company and the Government expired in 1976, the Prime Minister opposed the renewal of the contract. At that time, various problems had arisen and a strong Mauritian conglomerate was exerting pressure not to renew the contract with the Japanese and to sign a similar contract with the Soviets instead. The Japanese, who at the same time were having difficulties with the Malagasy Government, decided to throw all their weight in the balance. Following the arrival in Mauritius of a high official of the Mitsubishi group, the affair was resolved with a "working arrangement." (Source: IFR-77/133.)

According to the NMFS Office of International Fisheries, reports indicate that the Government of Guinea-Bissau is also dissatisfied with its fisheries agreement with the Soviet Union. In May 1975, Guinea-Bissau and the USSR established a joint venture company, Estrela do Mar, to develop Guinea-Bissau's offshore fisheries. Under the terms of this agreement, the USSR was to supply fuel for five fishing vessels it donated to Guinea-Bissau in exchange for fishing rights in Guinea-Bissau-claimed waters.

Although the USSR did provide a few vessels as stipulated in the agreement, they turned out to be the wrong class for use in coastal fisheries and, in addition, the Soviets insisted on providing the crews themselves. The promised training program and processing facilities have not yet materialized. There have been articles in the government-controlled press claiming that the dozen or so Soviet trawlers that operate out of Guinea-Bissau are literally scraping the bottom of the sea clean.

[1]The exchange rate is approximately 6.6 Mauritian rupees = US$1.00.

[2]This company is believed to be the Kaigai Gyogyo Kabushiki Kaisha.

FRESHWATER SHRIMP FARMING ATTEMPTED

The northern Japanese city of Sapporo in Hokkaido started experimental culture of Indonesian freshwater shrimp in July 1977, according to a *Minato Shimbun* report. Because the tropical shrimp "onitenagaebi" requires an optimum temperature of 30°C and will not survive at temperatures below 15°C, the municipal authorities will use hot spring waters in the vicinity of Jozankei. The aquaculture project will be located at Lake Jozankei near the city and will be assisted by the prefectural hatcheries. The males of this species grow to 40 cm and weigh 500-600 g 12 months after hatching.

Sixteen Polish Trawlers Slated for Soviet Union

Sudoimport, Russia's vessel importation association, and the Polish foreign trade association "Centromor" have signed a large contract in Moscow, according to a report in the *Ekonomicheskaia gazeta*.

From 1978 to 1980, 16 fish-processing trawlers, 1,800 dwt each, are expected to be delivered to the Soviet Union. The vessels will be constructed at the V.I. Lenin wharf in Gdansk. In conjunction with the previously signed contract, 10 supertrawlers for harvesting tuna on the open seas will also be delivered to the Soviet Union from Poland during this same period.

Guinea-Bissau's State Secretary of Fisheries was in Moscow in July to renegotiate the agreement. Reportedly, two main Guinea-Bissau demands were to be the complete reorganization of Estrela do Mar and a reduction in the rents paid to the Soviet Union for the use of the fishing vessels.

Krill Harvest, Fleet Plans Told by Japan

During the 1976-77 Antarctic summer season, the five-vessel Japanese krill harvesting effort yielded a total of 12,000 t of krill, some 2,000 t more than had been anticipated, according to Japanese news reports. All aspects of experimental krill harvesting have now been completed, leaving processing and marketing research for the future.

The semi-governmental Japan Marine Resource Research Center and Taiyo jointly experimented in shelling the tiny crustaceans on factory vessels. The shelling was done on both boiled and raw krill, and a "spectacular expansion" of krill utilization and marketing possibilities were reported.

The Fisheries Agency of Japan also was organizing a fishing fleet led by a factory ship to harvest Antarctic krill during fall 1977. The fleet was to consist of one refrigerated transport owned by various independent companies.

The trawlers, which used to operate as independent vessels catching Alaska pollock in what has become the Soviet 200-mile fishery zone, will function as krill "catcher boats." The semi-governmental Japan Marine Fisheries Resource Research Center planned to charter all the vessels and administer the fleet operation, thus acting as an arm of the Government to subsidize the operation.

Last summer, Taito Seiko Company, a leading Japanese manufacturer of fishing nets and ropes, began manufacturing krill nets for use on the 349 GT trawlers. The nets were designed to work efficiently with smaller thrusts. Conventional Japanese krill nets are suitable for use on 3,000 GT trawlers having enormous thrusts. The new nets were to be available for the pending Antarctic summer season at a cost approximately 50 percent above that for a conventional krill net.

Monbetsu Fisheries Cooperative Association of Hokkaido has been successfully utilizing mixed feed containing dried Antarctic krill to culture king salmon. The experimental culture of king salmon is conducted in Lake Saroma near Monbetsu city. Krill is used to intensify the pink color of the salmon flesh for higher prices at the markets. The salmon is expected to sell for 1,500 yen/kg (US $2.77/lb). (Source: Report 77-5, NMFS Language Services Branch.)

Japan Upgrades Fishery Agency, Appoints New Research Center Chief

Japan's Agriculture and Forestry Minister, in a mid-summer press conference in Tokyo, disclosed that the status of the Fisheries Agency of Japan would soon be elevated to that of a ministry. Although the Agency would not become an independent ministry, its current parent organization will change its name to the "Ministry of Agriculture, Forestry and Fishery."

The Agency will receive in FY78 increases in funding despite the current administration-wide budget freeze. One of the programs to receive an increased funding is ocean ranching. The Agency is currently preparing a submission requesting the establishment of a new division called the Coastal Fisheries Development Division, which will administer all phases of ocean ranching.

Hirotake Fujimura has been appointed Director of the Board of the quasi-governmental Japan Marine Fisheries Resource Research Center. The new director intends to emphasize not only the development of new fishing grounds, but also research in marketing novel Anatarctic fish species.

With regard to the Center's new project, surveying fisheries in the vicinity of the Kerguelen Islands, Fujimura denied the rumor that it was a made-up project for vessels retired from the northern seas fisheries. He also emphasized the importance of the Center's involvement in future surveys of the world's potential fisheries. He maintains that individual fishing companies are no longer capable of conducting comprehensive survey activities, such as the recent private surveys carried out off the Argentine and Chilean coasts. (Sources: Japanese news articles and Report 77-5, NMFS Language Services Branch.)

Japan's Salmon Fishermen Oppose Vessel Retirement

Japan's major salmon fishing companies expressed their strong opposition earlier this year to the Fisheries Agency's proposal to retire four salmon mothership fleets, according to a report in the *Minato Shimbun*.

The Fisheries Agency's proposals were prompted by the Japanese Government's willingness to accept the Soviet quota for a Japanese salmon fishery of 62,000 t for 1977. The government was ready to accept that quota because the Soviets indicated that Minister Ishkov himself increased the figure to 62,000 t by allowing 5,000 t more than the initial figure. The difficulties the Japanese salmon fishery faces are compounded by complicated Japanese domestic conflicts among the three segments of the industry, namely the large companies operating mothership fleets (332 vessels), medium-sized companies operating salmon driftnet vessels (368 vessels), and the coastal fishermen strongly dependent on the salmon fishery for their livelihood (1,120 vessels).

The Fisheries Agency's plan to reduce the number of independent salmon fishing vessels by 20-30 percent was viewed by powerful fleet owners as being too protective of the small companies. In 1976, a lean-year total of 80,000 t of salmon was harvested; fishermen were hoping to harvest at least 87,000 t this year, which is a bounty year.

Growth Predicted for Moroccan Fisheries[1]

Morocco's fishing industry will grow rapidly during the next few years, and sardines and trumpet fish will play major roles in this expansion, the NMFS Office of International Fisheries reports. Considerable improvements in the fishing fleet, establishment of a refrigeration network, and modernization of plant facilities will be required, however, if Morocco is to reap the benefits of its fisheries resources. The expansion of the nation's fishing industry is creating significant trade opportunities for U.S. companies.

CATCH

Morocco's 21,000 fishermen landed nearly 236,000 metric tons (t) of fishery products in 1975, according to the Office National des Pêches (ONP) of Morocco[2]. This included 206,000 t of "industrial" fish used for canning or reduction into fish meal, 29,400 t of fresh fish for domestic consumption, 481 t of crustaceans, and 52 t of mollusks. Fishermen at the Atlantic Ocean ports of Agadir, Essaouira, and Safi (Fig. 1) landed 79 percent of the total catch, followed by fishermen in Casablanca (16 percent), and the Mediterranean port of Al Hoceima (5 percent). The rest of the catch (less than 1 percent) was landed in 13 smaller fishing ports.

Sardines played a leading role in Morocco's fisheries in 1975, as they have for years, and accounted for 79.5 percent of all landings. The 1975 sardine catch of 167,400 t, however, was 52 percent below the 1973 catch of 349,300 t (Table 1). This decrease was anticipated because Morocco's sardine fisheries are influenced by upwelling which changes in a cycle. The upwelling off Morocco peaked in 1973, producing abundant plankton, an essential food for sardines and their larvae. Moroccan marine scientists expect sardine catches to continue decreasing through 1977 and then to begin increasing, as meteorological and oceanographic forces begin to gather strength, until 1980 or 1981 when another record upwelling and sardine harvest is predicted.

Catch variations have also been caused by a southward migration of sardines from the traditional grounds off Safi, Essaouira, and Agadir to the waters off the Western Sahara. This migration has particularly affected the northern ports, especially Safi, which reportedly received only 16 percent of the amount of fish needed to operate the processing plants at full capacity. The obsolescence and limited range of the Moroccan fishing fleet prevented the fishermen from operating in distant waters to compensate for the decreasing catches on their traditional sardine fishing grounds.

Table 1.—Morocco's sardine catch and total fish catch, 1971-75.

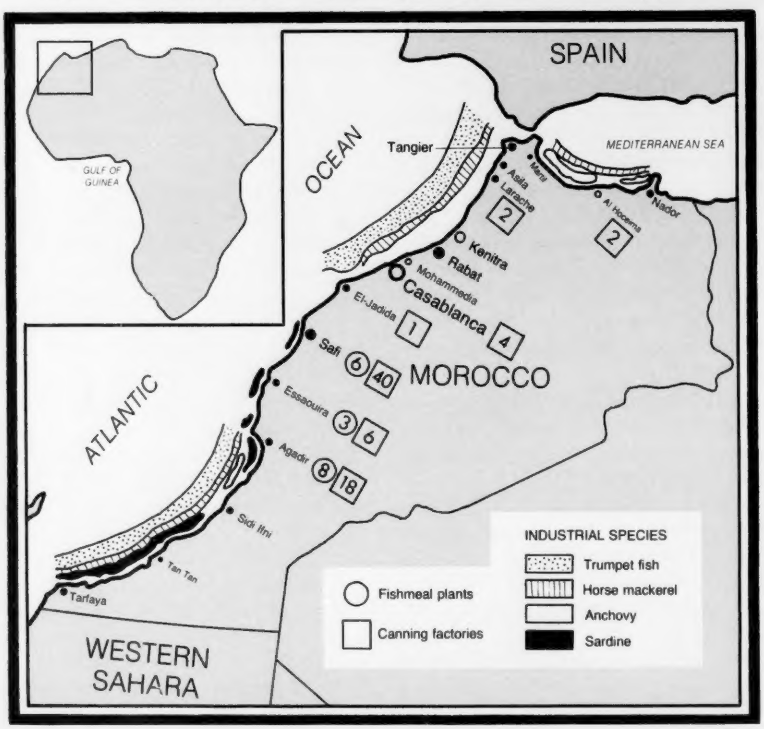
Year	Catch (1,000 t) Sardines	All fish	Percent[1]
1971	183.3	226.7	80.8
1972	185.0	246.4	75.1
1973	349.3	398.3	87.7
1974	224.2	288.1	77.8
1975	167.4	210.5	79.5

[1]Sardine catch as a percentage of the total fish catch.
Source: FAO "Yearbook of Fishery Statistics", 1975.

Studies have shown that there are enormous quantities of trumpet fish (*Macrorhamphosus* spp.), a "trash fish" which is now being thrown away. The fish meal industry is trying to reduce trumpet fish, and if these efforts are successful, this unutilized species could help to make Morocco an important fish meal producer and open up a new fishery.

Mackerel and anchovy landings remain small; these fish are canned for export. Tuna was once caught in quantity off the coast of Morocco, but is no longer being landed in large amounts.

Figure 1.—Morocco's principal fishing ports, processing facilities, and fishing grounds.



[1]This report was prepared by William B. Folsom, U.S. Regional Fishery Attache for Africa, and Susan D. Foster, Foreign Affairs Aid, Branch of International Fisheries Analysis, National Marine Fisheries Service, NOAA, Washington, DC 20235. A full report, "Fisheries of Morocco, 1975," by W. B. Folsom (No. 77-08-010, 130 p.) is available from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161 for $6.00.
[2]ONP data do not agree with FAO statistics.

Two Moroccan companies, however, have been established to fish for tuna in the Gulf of Guinea[3]. Morocco's small shrimp and lobster fisheries could both be expanded and the product exported.

GROUNDS AND SPECIES

The major development in Morocco's fisheries in 1976 was the opening of the waters off the Western Sahara (formerly Spanish Sahara, Fig. 2) to Moroccan fishermen.[4] These new fishing grounds are believed to contain 1.7 million t of sardines—three times the amount found on Morocco's traditional sardine ground. This resource could make Morocco one of the world's largest sardine producers.

Although Morocco does not have the technical ability and fleet to make the best use of these resources, its Office National des Pêches (ONP) has a plan for the management of the zone. Foreign fleets wishing to operate in these rich waters will be required to conclude agreements with Morocco. The ONP Director has indicated that Moroccco intends to benefit from landings of not only its own companies but of a large fleet of perhaps 500 vessels flying the Moroccan flag[5]. At present, Morocco does not have a fishing port where large factory trawlers, which operated off the Western Sahara and were previously based at Las Palmas, can offload their catches. A new, well-equipped port will be needed if the Saharan resources are to be fully developed, and both Cabo Bojador and Dakhla (Fig. 2) have been suggested as possible sites; Morocco sent several trawlers to Dakhla in 1976. Adequate facilities already exist at Las Palmas in

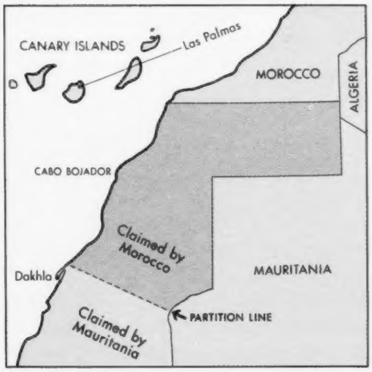


Figure 2.—Western Sahara area now claimed by Morocco, showing the partition line as defined in the 14 April 1976 accord signed by Mauritania and Morocco.

the Canary Islands, but the Moroccans want to avoid dependence on a foreign port. A cold storage plant will also be required to hold the fish prior to export.

Raids by Polisario guerillas are now inhibiting efforts of Morocco and Mauritania to cooperate on economic development programs, and little has been done so far to utilize the vast fisheries resources of the Western Sahara.

PROCESSING

Antiquated fishing vessels, poor handling, lack of refrigeration, and outdated processing plants result in heavy damage to fish which could otherwise be used for human consumption. About half of the total catch is reduced to fish meal. Only 30 percent is canned, 15 percent is sold locally as fresh fish, and the rest is frozen by a developing freezing industry.

The development of the freezing industry in Morocco has been hampered by a lack of ice, since ONP joint venture company vessels have priority in the supply of ice; domestic ice production is insufficient to meet the demands of both the freezing industry and the ONP joint venture companies. There is also competition between the canners and the freezing industry for raw fish. Despite this, there are five freezing companies at Agadir which produce 98 percent of Morocco's frozen fish.

The freezing industry is more efficient than the canning industry as it uses 26 percent more of the raw fish and uses very little imported material; the canning industry utilizes imported materials (tin, oil, cardboard cartons) for a large part of the final product. Proponents of the freezing industry also point out that it creates jobs; over 100 persons are employed full-time and another 1,000 to 1,500 are employed seasonally for 120 to 160 days a year. If the fish used for freezing was distributed between the canning factories, there would be no need for extra workers and therefore more than 1,000 workers presently working in the freezing industry would become unemployed.

OFFICE NATIONAL DES PÊCHES

The Office National des Pêches (ONP) is a semi-governmental agency established in 1969. The ONP is responsible for developing and modernizing Morocco's fisheries, and has helped artisanal fisherman buy new fishing gear and establish fishery cooperatives. The ONP worked to enact a maritime investment code designed to stimulate investments in new fishing vessels. Joint venture fishing operations with several nations have been established through the ONP, thus bringing new technology and methods to Morocco's fisheries. In addition, through the efforts of the ONP, a 70-mile fisheries zone has been established. Morocco's fish consumption, which was only 4.2 kg per capita in 1970, has been stimulated by the formation of a special firm created by the ONP. The firm, ASMAK, sells fresh and chilled fish in the interior of Morocco. The ONP also conducts fisheries research.

The ONP director, Dahmane Layachi, was recently elected to Parliament as the delegate from Rabat, and he was to leave his post at the ONP in October when Parliament convened.

EXPORTS

Canned sardines are Morocco's principal export commodity and account for nearly half of all fishery exports. Exports of canned sardines have fallen from 62,000 t in 1973 to only 36,000 t

[3]One of these companies, Thonapeche, was established in 1975 by the Office National des Pêches. The company acquired two 42-m tuna vessels and was negotiating for another larger vessel. Thonapeche will eventually operate a fleet of nine tuna vessels.

[4]Following the withdrawal of Spain from the Spanish Sahara in early 1976, Morocco and Mauritania created a mixed commission to help develop the resources of the ex-Spanish Sahara. According to Article III of the Economic Cooperation Accord of 14 April 1976, both parties agreed to work together to develop the fisheries off the ex-Spanish Sahara.

[5]*Pêche Maritime*, 20 February 1977.

Table 2.—Morocco's exports of canned sardines to France, Zaire, and the Philippines, 1973-75.

	Exports (1,000 t)		
Year	France	Zaire	Philippines
1973	13.39	6.29	7.59
1974	15.16	5.23	1.12
1975	7.82	2.04	3.81

Source: Office des Changes, "Statistiques du Commerce Exterieur," 1973, 1974, and 1975. Ministere des Finances, Royaume du Maroc.

Table 3.—Moroccan fishery exports to the United States, 1974-76, by quantity (metric tons) and value ($1,000).

	All fish exports		Canned sardines		Percent[1]	
Year	Quantity	Value	Quantity	Value	Quantity	Value
1974	539.7	1,750.4	252.6	339.2	47	19
1975	631.1	990.0	213.9	298.4	34	30
1976	553.2	1,208.3	398.3	508.8	72	42

[1] Sardine exports as a percentage of the total Moroccan fishery exports to the United States.
Source: Bureau of the Census, U.S. Department of Commerce.

in 1975. Several factors other than declining catches are responsible for this decline. The European Economic Community (EC) has indicated its intention to establish a limit on the price of Moroccan sardines to protect the sardine markets of member countries. The price limit would not, however, be imposed on Spain, Portugal, or Greece, Morocco's main competitors on the EC market, because these three countries are expected to eventually join the EC.

Sardine exports to France, Morocco's most important market, decreased from 13,400 t in 1973 to only 7,800 t in 1975 (Table 2). This was attributed to competition from lower-priced Portugese products (especially since the nationalization of the Portuguese fishing industry), rising production costs, and the increase in the cost of imported materials, such as tin and cardboard, which account for 36 percent of the cost of a carton of canned Moroccan sardines. The unemployment of large numbers of foreign workers in France (the principal consumers of sardines) resulted in decreased purchasing power of these consumers and further decreased the demand for sardines. Wealthier French consumers turned to tuna, and in the Federal Republic of Germany canned herring was substituted for sardines to some degree. In addition, the special bilateral tariff agreements between Morocco and France were in conflict with EC policy, and Morocco feared that they might be substantially altered or eliminated entirely.

Moroccan canners apparently attribute the drop in canned sardine sales to the increased export of frozen sardines, especially to France. The canning industry has even suggested that Morocco import frozen fish to keep the canneries operating at full capacity. Some fishing industry spokesmen, however, maintain that exports of frozen fish are destined for a particular market and that most Moroccan frozen fish is not canned abroad. This line of reasoning is borne out by the fact that although Morocco limited exports of frozen fish during the second half of 1975 to only 814 t, canned sardine exports did not increase. The ban on exports actually proved detrimental to the Moroccan industry as a whole because Italian frozen sardine exports to France increased to fill the void left by the absence of Moroccan products; nearly 19,000 t were imported during the first 9 months of 1975, whereas only 3 years before, no Italian frozen fish was sold in France.

Morocco has been attempting to compensate for decreased sales to Europe by increasing exports to Africa and Asia, although the markets there are less lucrative and the prices lower. In Asia, the Japanese have engaged in speculation to protect their own fisheries export market, by buying Moroccan sardines in bulk and reselling them on the Asian market. As a result, the Philippines, the largest market for Moroccan sardines in Asia, accused the Japanese of "dumping" $3 million worth of canned sardines and mackerel on the market in 1975. The Philippines established tariff barriers in response to complaints by the Philippine fishing industry, which have hurt Moroccan sardine exports. Exports to the Philippines decreased from 7,600 t in 1973 to only 1,130 t in 1974 and 3,800 t in 1975 (Table 2).

Sales of canned sardines in Africa depend to a large extent on the quantity of Spanish sardines available and on unstable economic conditions in Africa. The economic difficulties of Zaire during the past 3 years, caused by the nationalization of many sectors of the economy and decreasing world copper prices, resulted in a sharp decline of sardine exports to Morocco's most important market in Africa. Zaire imported 6,300 t in 1973, but only 2,000 t in 1975.

United States imports of Moroccan sardines are gradually increasing[6]; 1976 imports amounted to 398 t, an increase of 46 percent over 1975 imports of 214 t (Table 3). Moroccan sardines, however, made up less than 2 percent of total 1976 U.S. canned sardine imports of 25,800 t.

Morocco is an excellent area for U.S. investors or exporters able to develop Morocco's marine resources. Opportunities exist for investors interested in establishing joint ventures with Moroccan partners in the areas of canning or filleting and freezing fish. Joint ventures might also be established for deep-water shrimp and lobster fishing, but a considerable period of experimental fishing will be required in order to locate suitable fishing grounds for these two species.

Exporters of cold-storage or freezing plants, plant machinery, fishing vessels, gear, engines, nets, electronic gear, etc. also have tremendous opportunities for sales in Morocco. In order to compete effectively, however, interested companies must be able to correspond in French and must have sales literature written in French. In preparing a sales proposal, the interested firm should realize that decisions can take months; personal visits will often generate more sales than a simple exchange of correspondence.

[6] U.S. imports of canned sardines (both in oil and not in oil) from all sources have fluctuated considerably in the past few years. In 1973 and 1974 U.S. imports were about 30,000 t, but imports declined to only 14,000 t in 1975. Shipments began to increase again in 1976 when over 25,000 t were imported.

Great Lakes 1976 Commercial Fish Catch Nets 102 Million Pounds, $21.1 Million

The waters of the Great Lakes provided U.S. and Canadian commercial fishermen with a catch during 1976 of some 102 million pounds having a record landed value of over $21 million, according to a *Great Lakes News Letter* report. While the weight total was up about a million pounds or 1 percent over the previous year's figure, the dollar return increased by nearly $2.5 million (over 13 percent) due to the sharp advance in dockside price paid for some species. Catch statistics obtained annually by the Commission from the U.S. Fish and Wildlife Service and the Ontario Ministry of Natural Resources are summarized in tables one and two.

An overall view of the vast freshwater fishery reveals substantial variation with respect to the species and size of the harvest taken from the several lake basins. In terms of fish production, Lake Michigan's 48.4 million pounds stands well above all others in accounting for 47 percent of the Great Lakes total. Lake Erie, however, continues as the most valuable commercial fishery with the 1976 Canadian-U.S. landed value amounting to $8.7 million or 41 percent of the value of the total lakes harvest. Catch statistics, it should be noted, may provide a misleading indicator of the abundance of some species in some areas since state regulations, bans due to chemical contaminants, and market demand are among the factors which can sharply reduce the quantities harvested.

The 65.7 million pounds of fish caught by U.S. commercial fishermen during 1976 was 5 million above the previous year, with 4 million of the gain being alewives. Although this species is common in all of the lakes except Superior, the commercial catch is essentially all from Lake Michigan. The 39.2 million pounds of alewives taken from that lake in 1976 accounted for 60 percent of the total weight of the U.S. Great Lakes production but for less than 5 percent of its dollar value. For Lake Michigan, last year's alewife harvest provided 81 percent of the lake's total production. This small, low-value fish is processed into fish meal, oil, and pet food.

The whitefish was the leading income-producer in 1976 among more than two dozen species caught in significant quantities by U.S. commercial fishermen. A dockside value of more than $4 million was a new high for this species which had three-quarters of its production come from Lake Michigan. Other important high-value species are the yellow perch and chub. Landings of the latter have decreased markedly due to the decline of this species in Lake Michigan which, in turn, has prompted the states to initiate measures to sharply reduce the commercial catch of chubs.

Table 1.—Total Great Lakes fish catch and value, 1976.

	Thousand pounds		Thousand dollars	
	1975	1976	1975	1976
L. Ontario				
U.S.	233	194	98	91
Canada	2,777	2,914	782	1,003
L. Erie				
U.S.	8,487	9,061	1,964	2,731
Canada	30,549	25,711	6,009	5,990
L. Huron				
U.S.	1,858	2,160	630	771
Canada	3,334	3,884	1,806	2,482
L. Superior				
U.S.	4,735	5,952	1,792	1,771
Canada	3,769	3,891	1,011	1,247
L. Michigan				
U.S.	45,348	48,370	4,562	5,057
Total				
U.S.	60,660	65,736	9,046	10,422
Canadian	40,428	36,400	9,609	10,721
Grand total	101,088	102,136	18,655	21,143

Table 2.—Great Lakes fish catch and value, 1976, by leading species.

	Thousand pounds		Thousand dollars	
	1975	1976	1975	1976
United States				
Alewives	35,216	39,212	406	476
Smelt	2,573	5,345	255	205
Whitefish	4,516	5,298	3,030	4,100
Carp	4,612	4,612	330	293
Yellow perch	3,037	3,113	1,545	2,478
Chubs	2,444	1,657	1,629	1,186
All other	6,141	6,498	1,851	1,685
Canada				
Smelt	17,333	18,243	1,202	1,355
Yellow perch	9,419	6,073	4,387	4,815
Chubs	1,249	1,540	771	1,216
Lake herring	2,205	1,380	426	289
Whitefish	1,203	1,336	811	968
White bass	2,580	1,131	709	519
All other	6,440	6,696	1,303	1,559

For the Great Lakes States, last year's catch by their commercial fishermen in the lakes was as follows (in thousands of pounds):

Illinois	264	New York	518
Indiana	200[1]	Ohio	7,783
Michigan	14,003[1]	Pennsylvania	336
Minnesota	3,162	Wisconsin	39,471[1]

The 1976 Canadian catch of 36.4 million pounds was the lowest total since 1964, but rising prices brought the landed value for this production to a new high of $10.7 million. A sharp drop in the Lake Erie harvest of yellow

[1]Alewife portion of catch: Indiana 2; Michigan 4,621; Wisconsin 34,590.

ADDITIONAL LORAN-C TRANSMITTERS OKAYED

The Department of Transportation has announced that three new LORAN-C transmitting stations have been authorized by the Coast Guard as part of the Southeast United States LORAN-C Chain. On approximately 1 July 1978, stations at Malone, Fla., Grangeville, La., and Raymondville, Tex., will become operational to provide navigation service in the Gulf of Mexico.

Existing LORAN-C chains are along the west coast, in the north Atlantic, the Bering Sea, north and central Pacific Ocean, and along the east coast. LORAN-C uses low-frequency signals that travel across land and water at specified speed. By measuring the time of signals from two or more stations with a special receiver, the operator can determine his location to within 0.25 of a nautical mile. By mid-1980, the final configuration of LORAN-C will be attained and the older and less accurate LORAN-A system (used widely by civilians since WWII) will be phased out completely.

perch during the last several years—from 18.0 million pounds in 1973 to 4.6 million in 1976—has been the key factor in the recent decline in Canadian landings. In response to the continuing lack of strong year classes of this species, last year's enforcement effort also was expanded in order to bring adherence to the 8-inch minimum size limit.

Yellow perch continues, however, to hold a commanding lead as an income producer, although the rainbow smelt has held top position in terms of weight for the past 3 years. The harvest of smelt, like yellow perch, is principally from Lake Erie waters—17.2 million pounds of an 18.2 million pound total for 1976—and plays a major role in this lake accounting for 70 percent of the weight of last year's total catch by Ontario commercial fishermen.

Pacific Coast 1976 Albacore Catch Down

The U.S. commercial catch of North Pacific albacore has averaged 44,642,000 pounds over the past 25 years. The 1976 U.S. commercial catch is projected to be 27,810,000 pounds down 43 percent from 1975 landings, and the lowest in 20 years, according to a report in the California Marine Advisory Program *Newsletter*. North Pacific albacore make annual trans-Pacific migrations and are subject to both the Japanese and the U.S. Pacific Coast fishery. It is generally accepted that these fisheries are exploiting 6 or 7 year classes of a single stock having extremely complex and little-understood migration patterns. Estimates of the average total harvest from this stock approach 220,000,000 pounds annually and represent about one-third of the world catch of albacore.

CONDITIONS AFFECTING THE FISHERY

The sharp decrease in 1976 commercial albacore landings was due mainly to poor environmental conditions and a decrease in fishing effort along much of the coast. Off Oregon and Washington in August, upwelling was apparently weak and fish did not concentrate consistently along the few thermal fronts that developed. Stormy weather also hampered fishing during the season. In addition, many of the albacore trollers turned to salmon trolling due to record catch rates and prices for salmon.

Late season success of albacore sport boats off Washington was due to the use of live bait. Warmer-than-average water temperatures off California during the spring and summer precipitated an early beginning to the season off Mexico, but the fish were mainly small. Good catches off northern California were not consistent and fish were also small. The southern California commerical fleet was favored early in the season with good catches and environmental conditions, a tolerant Mexican policy of extended jurisdiction, and the best market on record. From Washington to California, the price for albacore was up $200-285 per ton, but benefits to fishermen were partially offset by higher operating costs.

THE CALIFORNIA FISHERY

For the first time in many years a good albacore fishery developed in Mexican waters. In early June, fish appeared between Guadalupe Island and the mainland and they remained until September, then moved to local banks less than 80 miles from San Diego. The catch per boat averaged between 50 and 60 fish per day, and lengths of the fish ranged from 60 to 66 cm until mid-September when the average size increased to 80 cm.

During the summer, San Diego sport boats accounted for an estimated 150,000 albacore, averaging 12 to 15 pounds on trips often less than 60 miles from port. In late July and early August, a sport fishery developed close to shore off Avila Beach and Morro Bay. The southern California fishery was the best in 20 years.

Albacore fishing in northern California had very little in common with the south. By August, the fishery had just begun and catch rates varied between days with exceptionally large catches (300-500 fish) and those with almost no success. Fishing was concentrated in an area between Fort Bragg and Monterey, with major fishing at Guide and Davidson seamounts and the Farallon Islands. The fish were small until September, when some landings were predominated by 25- to 30-pound fish. For the most part, the schools were small fish, or mixed at best. Fishermen sometimes left these schools to look for schools of the larger albacore. A good price gave the fishermen flexibility in this regard.

By the end of September, California albacore landings were less than 14,500,000 pounds. By October, many commercial boats had left the fishery and San Diego sport landings dropped to zero. During mid-October, from 30 to 40 commercial boats continued to work off San Diego and in Mexican waters. The fish were small. The catch rate was 0.5 to 1 ton per day per boat. The total landings for California in 1976 are an estimated 16,000,000 pounds. This is a 44 percent decrease from the 25-year average, but slightly above the 1975 landings. (Source: Preliminary review compiled by Mark Pederson, Washington Department of Fisheries, for the Pacific Marine Fisheries Commission.)

SOUTH CAROLINA SURVEY LOCATES SUBTIDAL CLAMS

Concentrations of subtidal clams have been found in several areas of the South Carolina coast, according to an extensive survey of the state's clam resources reported by the South Carolina Wildlife and Marine Resources Department. The survey, begun in 1973 and 80 percent completed at the time of this report, was conducted by the state Marine Resources Division with funds provided by the National Marine Fisheries Service.

"We are somewhat disappointed not to have found more subtidal clam areas that possibly could be fished with

mechanical equipment," said shellfish biologist F. Holland Mills who was in charge of the survey. Mills explained that most of the state's clam resources are found in the intertidal zone, often in conjunction with oysters, and generally are not suitable for mechanical harvest.

The largest concentrations of subtidal clams that the survey has located are in the Santee estuary. A clam fishery, using hydraulic escalator harvesters, has evolved in that area based on the results of the survey. Seven harvesters currently are licensed to harvest clams in this area. Since 1974, about 70,000 bags of clams, valued at more than $500,000, have been harvested from the Santee area. Mills thought that, barring any environmental changes, this area could be harvested indefinitely on a rotational basis, but he sees little chance for significant expansion of the intertidal clam fishery beyond the present level.

The other concentrations of subtidal clams that the survey has located are in much smaller areas and are not currently being fished heavily by mechanical harvesters. Clams are sampled with square meter hydraulic patent tongs mounted on a specially designed 20-foot boat. About 30,000 bottom samples have been taken with 3,350 containing clams.

The survey area includes all bays, sounds, harbors, and small creeks from Little River to Savannah and it was expected to be finished by late summer.

Sportfish Not Affected by Menhaden Fishing Say URI Researchers

Striped bass and bluefish in Narragansett Bay, R.I., do not appear to be affected by heavy commercial fishing on their principal food source, menhaden, say University of Rhode Island (URI) researchers.

Sport fishermen around the bay have long asked for restrictions on commercial menhaden fishing since they feel it reduces menhaden to the point where bluefish and striped bass are "starved" out of the bay. However, 2 years of study on the interactions between menhaden and its two predators by URI biologists suggests that this claim is probably not valid.

"We calculated that even in a year when the menhaden population is low from natural causes or from heavy commercial fishing, there are still enough menhaden in the bay to feed these important fish," stated Candace A. Oviatt, the project leader. Oviatt is a research associate at the URI Graduate School of Oceanography.

The biologists undertook the study in order to help settle the dispute between commercial and sport fishermen over whether commercial menhaden fishing affects gamefish populations. Funded by the URI Sea Grant program, they have been gathering information on menhaden, its two predators, and the fishing pressure exerted on these fish by commercial and sport fishermen.

Menhaden is a valuable commercial fish. Its oil is used for industrial products such as paint and the remainder of the fish is processed into meal for poultry feed. The small fish usually moves into the bay in large schools to spawn during the spring and spends the summer there. In past years, approximately half a dozen menhaden fishermen, from Point Judith and out-of-state, have landed between 15 and 23 million pounds of fish. The fish are caught by purse seining. Fishermen try to avoid setting these nets around large gamefish, such as bluefish, because they will destroy the nets.

In their study, URI researchers first confirmed that menhaden is the major food of bluefish and striped bass by looking at the stomach contents of these two fish. Then Bruce A. Rogers and Deborah Westin conducted laboratory tests on adult gamefish to determine how much food the fish eat each day. They also made estimates of fish population based on sports and commercial fish landings. From these studies, the group concluded that menhaden fishing does not threaten the gamefish.

The study continued during the summer with emphasis on the size of the bluefish and striped bass caught. Oviatt explained that this information will be provided to resource managers for future use in managing the gamefish.

Escape Rings May Aid Blue Crabs, Crabbers

Escape rings built into commercial blue crab traps may prove effective for allowing small, illegal crabs to escape, and may even increase the catch of legal sized crabs. A study by the South Carolina Wildlife and Marine Resources Department has shown that when escape rings are built into the standard chicken wire crab trap used extensively by commercial crabbers, fewer crabs smaller than the 5-inch legal width are taken.

Under South Carolina law any blue crab less than 5 inches across the shell from spine to spine must be returned to the water. These small crabs have little market value because of the small amount of available meat. Because a standard crab trap will catch virtually all sizes of crabs, commercial crabbers are forced to cull their catch from each trap. The use of escape rings will reduce the time crabbers must spend culling their catch and should benefit the crab resource, according to Peter J. Eldridge who conducted the study.

"Our preliminary study has shown that an escape ring of 1.5 inches by 2.25 inches seems to work the best," said Eldridge, who explained that the crabs move sideways through the rings. "By letting the small crabs out there seems to be more room for the big crabs," said Eldridge, "and the little crabs don't eat all the bait." Eldridge planned some further studies of escape rings, hoping to encourage some commercial crabbers to test traps equipped with escape rings.

Swordfish, Oysters, and Shrimp Poachers

. . . . **South Carolina's first two rod and reel swordfish** were docked in Charleston in early August. The Florida-developed night-fishing technique which took the 360- and 481-pound swordfish uses a squid rigged on a trolling line, followed 2-3 feet behind by a small cylindrical chemical light taped to the leader. As the boat drifts with the current, line is released, and the bait sinks to 250-300 feet where, apparently attracted by the light, the swordfish take it. . . .

. . . . **Last summer's Chesapeake Bay oyster set bodes well** for the 1980 harvest according to early test plate readings, the Maryland Department of Natural Resources reports. Monitors found "exceptionally good settings" on test plates in central and lower bay areas in mid-summer, though they cautioned that the extent of the real set on natural bars and planted shells would not be known until late fall or early winter. Said oyster propagation chief Harold A. Davis, "Many of our test plates contained anywhere from 200 to 300 spat, whereas last summer, plates contained from zero to half a dozen." Improved salinities up to 16 ppt in lower bay areas "might be responsible for the improved test plate sets," Davis added. . . .

. . . . **Texas game wardens confiscated some 60,000 pounds of Gulf shrimp** during the closed season, 1 June - 15 July 1977, the Parks and Wildlife Department has reported. The amount was double that seized last year. Wardens also apprehended 122 boats, 37 more than last year, in the 45-day period and $20,000 in fines were collected from 171 cases filed. Revenue from the confiscated seafood was $74,000. The increase in cases was attributed partly to shrimp abundance, but mostly to more efficient patrol boats. . . .

. . . . **Bullfrog culture may become a profitable industry** in Louisiana if researchers can solve feeding problems and can get a "super frog" to spawn on command, the Louisiana Wildlife and Fisheries Commission reports. About one in every hundred tadpoles quickly grows to as much as 1 pound in 4 months, say scientists. Most bullfrogs weigh only ⅓-½ pound at 10-12 months past metamorphosis. However, researchers note that until the frogs can be spawned under controlled conditions, large-scale culture will be hampered. . . .

Rana catesbeiana

. . . . **Wastes dumped off U.S. Atlantic and Gulf coasts declined** for the third consecutive year, according to "Ocean Dumping in the United States: Fifth Annual Report," by the Environmental Protection Agency. Dumping dropped almost 600,000 tons during 1976 alone, from 8,881,500 tons to 8,319,000 tons. The drop was due primarily to a decline in the ocean disposal of industrial wastes, which fell almost 21 percent from the 1975 level. In the Gulf of Mexico, industrial waste disposal has been slashed to 7 percent of the tonnage dumped in 1973. Meanwhile, a slight increase in ocean disposal of sewage sludge was noted. . . .

. . . . **South Carolina's fall white shrimp catch was expected** to be "well below normal"—perhaps the worst in recent years—because the species failed to recover from the exceptionally cold winter that all but wiped out the population, according to the Wildlife and Marine Resources Department. Last year's catch of fall white shrimp in the State amounted to 2.7 million pounds (heads off), worth $4.9 million, or 44 percent of the total value of the shrimp catch for the year. Brown shrimp, unaffected by the cold winter, usually make up only about 30 percent of the state's commercial shrimp catch. . . .

. . . . **Some 4,956 striped bass were tagged** by the California Department of Fish and Game in the San Joaquin River near Antioch last spring, about 20 percent of which were tagged with $5 or $10 reward tags. Creel checkers noted 21,638 striped bass in San Francisco Bay Area angler's catches in 1976, compared with 27,058 in 1975. Partyboats reported taking 10,711 stripers during 12,263 angler days in 1976, averaging 0.87 fish per angler day. Comparable figures for 1975 were 11,792 fish and 0.99 fish per angler day. . . .

. . . . **Snook, sometimes speared by divers around rocky jetties** in Texas, are apparently increasing there according to the Parks and Wildlife Department. Some snook always were found when there was a cold-weather fish kill along the lower coast, but more of the prized fish are now showing up on stringers and biologists are finding more snook in cove rotenone samplings. A summer sample in Lower Laguna Madre found 15 snook ranging up to 15 pounds with an average weight of 1½ pounds. . . .

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